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WIRE APPARATUS FOR LABORATORY USE.

By GEO. M. HOPKINS.

BEFORE the year 1351 everything known as wire was hammered out by hand, but at that date or thereabout the art of wire drawing was invented. Since then the art has been developed and expanded, so that at the present time wire drawing is a leading industry, and we have wire of every size and shape made from all of the ductile metals, and used in an infinite number of ways.

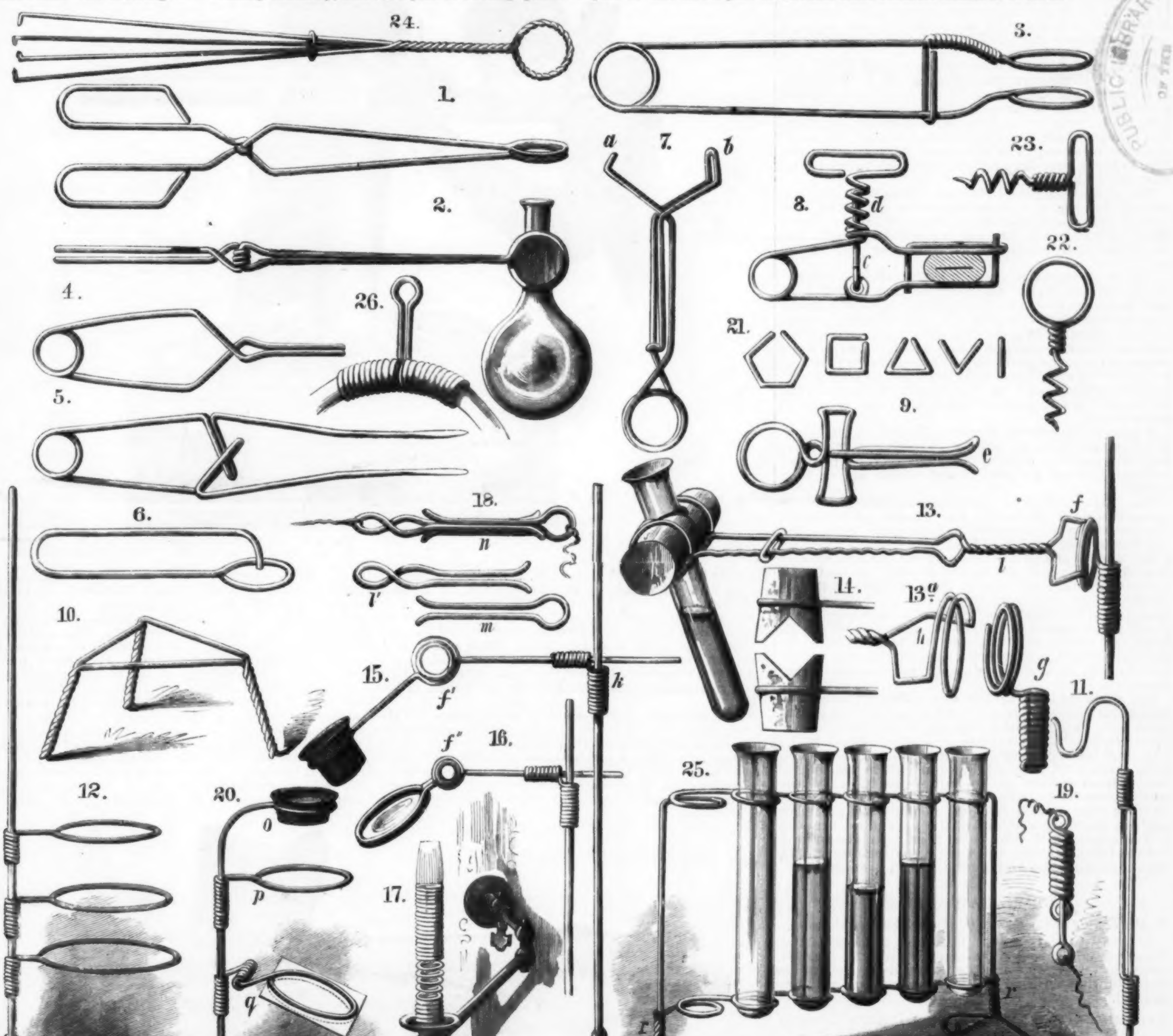
It is not my purpose to enter into an extended treatise on wire, but simply bring to the notice of the reader several new as well as some well known forms of laboratory appliances made of wire; and while I am conscious that this subject is by no means exhausted, I believe that the few examples of wire apparatus for the laboratory given in the engraving will not only be found useful, but will prove suggestive of other things equally as good. I have found wire invaluable for these and kindred purposes, and have often made pieces of apparatus in the time that would be required to order or send for them, thus saving a great deal of time, to say nothing of expense, which is no inconsiderable item in matters of this sort.

It is perhaps unnecessary to describe fully in detail each article represented in the engraving, as an explanation of the manipulations required in forming a single piece will apply to many of the others

For most of the apparatus shown, some unoxidable wire should be selected, such as brass or tinned iron, and the tools for forming these articles of wire consist of a pair of cutting pliers, a pair of flat and a pair of round nosed pliers, a few cylindrical mandrels of wood or metal, made in different sizes, and a small bench vise. Any or all of the articles may be made in different sizes and of different sizes of wire for different purposes.

Fig. 1 shows a pair of hinged tongs, which are useful for handling coals about the furnace, for holding a coal or piece of pumicestone for blowpipe work, and for holding large test tubes and flasks, when provided with two notched corks, as shown in Figs. 2 and 14. These tongs are made by first winding the wire of one half around the wire of the other half to form the joint, then bending each part at right angles, forming on one end of each half a handle, and upon the other end a ring. By changing the form of the ring end the tongs are adapted to handling crucibles and cupels and other things in a muffle.

Fig. 3 shows a pair of spring tongs, the construction of which will be fully understood without explanation. It may be said, however, that the circular spring at the handle end is formed by wrapping the wire around any round object held in the vise; the rings at the opposite end are formed in the same way. The best way to form good curves in the wires is to bend them around some suitable mandrel or form.



WIRE APPARATUS FOR LABORATORY USE.

1, 2, and 3. Tongs.—4. Spring Clamps.—5. Spring Pliers.—6. Spring Clamp.—7, 8, and 9. Pinch Cocks.—10. Stand.—11. Adjustable Support for Tubes.—12. Retort or Filter Stand.—13, 14. Test Tube Holder.—15. Holder for Magnifier. —16. Holder for Condenser.—17. Heating Burner.—18, 19. Electrical Connectors.—20. Microscope Stand.—21. Aluminum Grain Weights.—22, 23. Corkscrews.—24. Cork Puller.—25. Test Tube Stand.—26. Rubber Tube Support.

Fig. 4 shows a spring clamp for holding work to be soldered or cemented. It may also be used as a pinch cock.

Fig. 5 represents a pair of tweezers, which should be made of good spring wire flattened at the ends. Fig. 6 is a clamp for mounting microscope slides, and for holding small objects to be cemented or soldered. Fig 7 is a pinch cock for rubber tubing; its normal position is closed, as in the engraving, but the end, *a*, is capable of engaging the loop, *b*, so as to hold the pinch cock open. Fig. 8 shows a clamp or pinch cock having a wire, *c*, hooked into an eye in one side, and extending through an eye formed in the other side. This wire is bent at right angles at its outer end to engage a spiral, *d*, placed on it and acting as a screw. The open spiral is readily formed by wrapping two wires parallel to each other on the same mandrel, and then unscrewing

one from the other. The handle will of course be formed by aid of pliers. Fig. 9 shows still another form of pinch cock. It is provided with two thumb pieces, which are pressed when it is desired to open the jaws. Fig. 10 is a tripod stand, formed by twisting three wires together. This stand is used for supporting various articles, such as a sand bath or evaporating dish, over a gas flame. It is also useful in supporting charcoal in blowpipe work.

Fig. 11 shows a stand adjustable as to height for supporting the beak of a retort, or for holding glass conducting or condensing tubes in an inclined position. The retort or filter stand, represented in Fig. 12, is shown clearly enough to require no explanation. Should the friction of the spiral on the standard ever become so slight as to permit the rings to slip down, the spirals may be bent laterally, so as to spring tightly against the standard. Fig. 13 shows an adjustable test tube holder, adapted to the standard shown in Fig. 12, and capable of being turned on a peculiar joint, so as to place the tube in any desired angle. The holder consists of a pair of spring tongs, having eyes for receiving the notched cork, as shown in Fig. 14. One arm of the tongs is corrugated to retain the clamping ring in any position along the length of the tongs. The construction of the joint by which the tongs are supported from the slide on the standard is clearly shown in Fig. 13 *a*. It consists of two spirals, *g*, *h*, the spiral, *h*, being made larger than the spiral, *g*, and screwed over it, as shown in Fig. 13. This holder is very light, strong, and convenient.

Fig. 15 represents a holder for a magnifier, which has a joint, *f*¹, similar to the one just described. The slide, *k*, is formed of a spiral bent at right angles and offset to admit of the two straight wires passing each other. This holder may be used to advantage by engravers and draughtsmen. Fig. 16 shows a holder for a microscope condenser, the difference between this and Fig. 15 being that the ring is made double to receive an unmounted lens.

Fig. 17 shows a Bunsen burner, formed of a common burner, having a surrounding tube made of wire wound in a spiral, and drawn apart near the top of the burner to admit the air, which mingles with the gas before it is consumed at the upper end of the spiral.

Fig. 18 represents a connector for electrical wires, which explains itself. The part with a double loop may be attached to a fixed object by means of a screw. Another electrical connector is shown in Fig. 19, one part of which consists of a spiral having an eye formed at each end for receiving the screws which fasten it to its support; the other part is simply a straight wire having an eye at one end. The connection is made by inserting the straight end in the spiral. To increase the friction of the two parts, either of them may be curved more or less.

A microscope stand is shown in Fig. 20. The magnifier is supported in the ring, *o*. The ring, *p*, supports the slide, and the double ring, *q*, receives a piece of looking glass or polished metal, which serves as a reflector.

Fig. 21 shows a set of aluminum grain weights in common use. The straight wire is a one grain weight, the one with a single bend is a two grain weight, the one having two bends and forming a triangle is a three grain weight, and so on. Figs. 22 and 23 are articles now literally turned out by the million. It is a great convenience to have one of these inexpensive little corkscrews in every cork that is drawn occasionally, thus saving the trouble of frequently inserting and removing the corkscrew. The cork puller shown Fig. 24 is old and well known, but none the less useful for removing corks that have been pushed into the bottle, and for holding a cloth or sponge for cleaning tubes, flasks, etc.

Fig. 25 shows a stand for test tubes. The wire is formed into series of loops, and twisted together at *r* to form legs. A very useful support for flexible tubes is shown in Fig. 26. It consists of a wire formed into a loop, and having its ends bent in opposite directions to form spirals. A rubber tube supported by this device cannot bend so short as to injure it. Most of the articles described above may be made to the best advantage from tinned wire, as it possesses sufficient stiffness to spring well, and at the same time is not so stiff as to prevent it from being bent into almost any desired form. Besides this the tin coating protects the wire from corrosion and gives it a good appearance.

AERIAL NAVIGATION.

To the Editor of the Scientific American Supplement:

In reply to the article "Capazza's Lenticular Balloon," described and illustrated in vol. xix., No. 491, dated 30th inst., we would be thankful for publishing the following as soon as possible in your valuable journal.

CAPTAIN PETERSEN'S NAVIGABLE DOUBLE CONICAL BALLOON.

It was as early as 1859 when Captain Carl W. Petersen, of 262 Thirteenth Street, South Brooklyn, N. Y., first invented the said balloon, at the time when he was visiting the Arctic seas as an American whaler. The object of this invention was to produce a better means for overcoming the great difficulty of the Arctic ice, that still to-day stands an insurmountable barrier to a reliable mainway to the center of the North Pole. At those early days of navigable ballooning he knew of no mechanical power suitable for the operation of aerial vessels, and as a seaman it suggested itself to our captain to tack in the air with his balloon in a vertical plane, similar to sailing vessels tacking the sea in horizontal planes; thus the ascent upward and forward was to be effected by the overdue ascensional force of the lifting medium within the balloon, and the descent was effected by reefing the balloon (making it smaller), thereby depressing the gas and decreasing the lifting force of same to such an extent that the machine becomes heavier than the air, thereby causing it to shoot on its surface forward and downward. After arriving near enough to the ground or sea, the means for decreasing the balloon are lessened, the gas expands and increases in lifting power, which causes the air ship to go 'bout-ship and shoot upward and forward again. The steering of his double conical balloon in any desired universal direction was performed by means of a long lever with a weight attached to its lower end, which was worked within the car, situated at the foot of the vertical mast passing through the balloon. After departing from sea life and from ship building and engineering, Captain Petersen visited the city of Washington, D. C., for the purpose of patenting this invention and many other valuable improvements in air navigation. However, the patent agent engaged argued with the Captain that the double conical balloon was not patentable, which is the true cause that little or nothing has been done as to the carrying out of this invention.

However, it is not our desire to discourage the new endeavor in the old field of air navigation, but we protest against Mr. Capazza announcing himself as the true inventor of the "double conical balloon," which Captain Petersen really is.

PETERSEN'S AM. AERIAL NAVIGATION CO.,
JOHN D. MULLER, *Treasurer.*
262 Thirteenth St., So. Brooklyn, N. Y., May 28, 1885.

HOTCHKISS MACHINE GUNS.

AMONG the artillery exhibits at the Inventions Exhibition, lately inaugurated in London, are the revolving cannons invented by the late B. B. Hotchkiss, of Bridgeport, Conn., and made by Hotchkiss & Co., of London and Paris.

FIG. 2.

They comprise a 47 mill. or 3-pounder revolving cannon and a similar gun of 53 mill., carrying a 4 lb. projectile. There are also two rapid firing guns; a 1-pounder, 37 mill. bore, and a 3-pounder, 37 mill.

The revolving cannon and the rapid firing gun form two distinct classes, the construction of which differs widely.

The larger type of this class of gun shown by the Hotchkiss Company is the 53 mill., and is mounted on its carriage ready for service, as illustrated by Fig. 1. The carriage rests on a foundation plate that is bolted to the ship's deck, and can be made to revolve around a circular rack, by means of a worm and wormwheel. The arrangement of elevating screw is clearly shown in the engraving. We also annex a few details from which a clear idea of the mechanism will be obtained.

The five revolving barrels, A A, Fig. 10, are made of Whitworth compressed steel, and are grouped around a central steel shaft, B, being held in position by two gun metal disks, C C¹. The barrels, shaft, and disks are mounted between plate frames, E E, which carry the trunnions, F. At the rear of the disk, C, is placed the cast iron breech block through which the shaft, B, passes, carrying at the inner end, and in a recess in the breech block, the pinwheel, *b*. The front part of this breech block is solid, and the back is formed with a chamber which contains the mechanism, and is closed with a hinged door, *d*. A spindle, F, runs through the chambered portion of the breech block at right angles to the axis of the gun. The projecting end of the spindle carries a small bevel wheel, *f*², to which a rotating motion is imparted by means of the cranked handle shown in the perspective view. On the spindle within the chamber is mounted a cam, K, set out in such a way as to gear with the pinwheel, *b*, and to give it, and through it to the barrels, an intermittent motion. By this means, while the man firing the gun turns the handle continuously, the barrels are brought successively into the firing position, when they are stopped long enough for the operations of loading, firing, and extracting to be performed. The loading and extracting mechanism is illustrated in Fig. 4 and Fig. 11, and is actuated by the spindle, F. Placed in a recess on the left hand side of the breech chamber is a toothed wheel, *m*, Figs. 4 and 11, gearing above and below with the racks, M¹ and L¹. To the former is attached the loading piston, M, and to the latter the extractor, L. To the rack, L, is also attached a curved and slotted rack, *f*, in which works the pin of a crank, I, mounted on the shaft, F. As the shaft rotates, the crank, I, imparts a reciprocating movement to the rack, L¹, and to the toothed wheel, *m*, which in its turn moves the upper rack, M, but in an opposite direction,

FIG. 1.

THE HOTCHKISS MACHINE GUNS.

the parts being so adjusted that while a new cartridge is being introduced in an upper barrel by the plunger, a cartridge case is being withdrawn by the extractor. The plunger does not, however, drive the cartridge completely home, but advances it upon a spiral incline, the rotation of the barrel causing it to slide forward into its ultimate position. The upper and the lower ends of the slots, *f*, are curved to a radius corresponding with the throw of the crank, I. Thus at each end of the stroke, and while the racks, M^1 and L^1, are in their extreme positions, a slight pause occurs in this part of the mechanism, though the barrels continue to revolve. This pause is necessary to allow the extractor to take hold and to permit of a fresh cartridge being introduced.

As is shown in the perspective view, Fig. 1, and the cross section, Fig. 4, the top of the breech chamber is provided with a slotted opening to admit the cartridges which are placed in a movable case, the lower end of which is inserted in the slot when rapid firing is required. For slow firing, however, the cartridges may be introduced singly by hand. The mode of firing is illustrated in Figs. 3 and 10. By the side of the large cam,

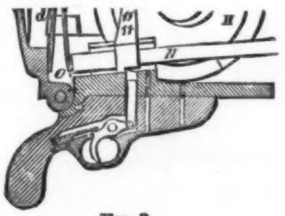


FIG. 2,

H, is a small spiral cam, G, which, as it revolves, presses back the arm, *n*, of the firing pin, N^1. This latter passes, as shown, through an inclined passage to the face of the breech-block. As the cam, G, forces the firing pin back, a strong plate spring is compressed by the end, O, of the pin, until the cam releases the arm, *n*, when the pin flies forward and fires the cartridge.

We may now follow the operation of this gun through one cycle of its operations. A cartridge is dropped from the feeding box on to the receiver in the breech chamber, bringing it axial with the bore. On the outside hand lever being turned, the rack, M, forces the plunger forward, and enters the shot into the barrel, which is not at that moment in motion. So soon as the cartridge is entered, the cam engages with the pin wheel and turns the barrel until that one containing the cartridge is brought round to the lowest position and opposite the firing pin, which has meantime been drawn back by the cam, G. The latter then releases the firing pin, which discharges the cartridge, and the barrels, which have in the mean time paused, again resume their motion for one-fifth of a turn, when the cartridge case is brought opposite the extractor, the jaws of which at that moment are advanced so far that the rim of the cartridge rolls between them as the barrels revolve. Then another pause occurs, during which the slot attached to the extractor rack withdraws the latter, with the empty case, until the case strikes against an ejector, which disengages it from the extractors jaws and throws it through an opening in the bottom of the breech chamber to the ground. At each pause of the barrels a new cartridge is introduced in one barrel while another is being fired and the case extracted from the third; the firing is practically continuous, and can be kept up steadily at the rate of forty rounds a minute when loaded with separate cartridges. For more rapid firing the cartridge cases containing ten rounds each are employed, and thus from sixty to eighty rounds a minute can be fired.

The ammunition consists of steel and common shell, and case shot. The first is used chiefly where great

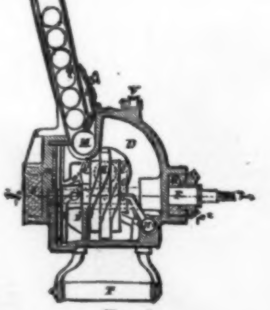


FIG. 4.

penetration is required, and the head is brought to a sharp point and hardened. The shot is surrounded with a coating of soft brass to take the rifling for about one caliber of its length. The forward part of this casing is tapered to fit a corresponding taper in the chamber of the barrel, so that the shot is accurately centered as soon as it is forced into the gun. The cast-iron shell is cylindrical with an ogival head, and is covered with the soft brass coating to take the rifling like the steel shot. The Hotchkiss percussion fuse is generally employed. The case shot has a canister of tinned iron with a lead capped base expanding when the cartridge is fired, and a conical zinc cap. The balls are made of lead and antimony, and are packed in the shot with sawdust. The cartridge core is made slightly conical, and is rolled up spirally of sheet brass. The head is of thin sheet iron, riveted to the brass case. The primer consists of a brass case, holding the anvil, and is closed at the bottom end by a cap containing the fulminate; it is fitted into a hole which penetrates the head and both cups, and it projects through into the inside of the cartridge case. The cups are pushed up around the primer cavity, so as to form a gas check for the primer. The construction of the body of the cartridge allows it to expand to the chamber of the gun without tearing the metal; after the discharge it contracts itself again, thus leaving the fired case perfectly loose in the chamber for extraction.

Two examples of the Hotchkiss rapid firing gun are exhibited, one of 37 millimeters, especially for torpedo boats, and one of 47 millimeters, throwing a 1 lb. and a 3 lb. projectile respectively. There are five types of this class of gun manufactured, of 37, 47, and 57 millimeters, two of 37 and 47 millimeters firing the same ammunition as the Hotchkiss revolving cannon, and three of 37, 47, and 57 millimeters in which heavier powder charges and projectiles are employed.

Fig. 2 shows the general appearance of the gun, with the method of mounting, the ammunition, and a shield for the protection of the gunner. It is a single barreled arm, mounted on a swiveling carriage, and can be easily trained in any direction. The body of the gun is made of Whitworth compressed steel with a square breech, and the steel trunnion ring is fixed in such a position that the gun is exactly balanced. The breech block with which the piece is fitted slides vertically between guides, and is actuated by a lever, which also acts as the trigger guard.

The details of construction are shown in Figs. 3 to 7. The breech mechanism comprises the square wedge, A, the guides just referred to are shown at BB, and the traverse of the block is limited by the set screw, P (Fig. 6). In the right hand side of the breech is a crank, C, with a pin, *c*, working in a curved groove in the breech lock. On the crank, C, is a lever, E, by which the breech is opened, by pushing the lever downward, while it is closed by pulling it up toward the pistol grip, Q.

The firing mechanism is clearly illustrated in the figures. It consists of a hammer, F, the upper end of which is pointed, and which strikes the cap of the cartridge when the trigger is pulled. The hammer is mounted on a rocking shaft, G, which has an arm, *g*, outside the breech. On the lever, E, is a cocking cam, *e*, that bears on the arm of the rocking shaft, and the piece is cocked by pulling down this lever. On the hammer is a small projection, *f*, which engages in the sear spring, H, and is held up by it till the trigger is pulled. The main spring is shown at I, and its upper branch bears against a projection on the bottom of the hammer. The cartridge extractor consists of a prismatic shaped piece of steel, hooked at one end, and sliding in a recess on the inner side of the left cheek of the breech in a direction parallel to the bore of the gun. On the underside of the extractor is a stud, which works in a groove formed on the left hand side of the wedge. As the latter is withdrawn, the stud runs along the straight portion of the groove, but is afterward forced in an inclined position, which gives a rapid travel to the extractor and causes the fired cartridge to be ejected.

As will be seen from the drawings, this gun is provided with a stock, which bears against the left shoulder of the man firing, while the pistol stock comes conveniently to the right hand; by this arrangement one man can train or fire the gun, keeping his sight always on a moving object. At the back of the stock a rubber lining is added which reduces the shock on firing. The pistol grip is of gun metal, made hollow, and containing the trigger, *q*; the gun can be directed by the right hand, thus leaving the left free to feed in the cartridges. The rear sight, as shown in the drawing, is a folding leaf with notches corresponding to elevations of from 200 to 300 meters, and giving also permanent deviations, so that the gunner can pass from one range to the other without interruption. The front sight is a plain steel point on a collar placed around the gun.

One method of mounting is shown in the perspective view, and another somewhat different in the side elevation. The pivot and socket on which the gun turns are of gun metal, and the trunnions rest in bearings in the upper part of the pivot, so that a universal movement is obtained. The bearings of the trunnion are lined with rubber to absorb recoil. The following are the different manipulations required for working this gun:

1. The lever is thrown down by pressing with the thumb of the right hand. This is done with a jerk to eject the cartridge shell.
2. The cartridge is inserted with the left hand.
3. The lever is returned to its place with the palm of the hand, which raises the block into its firing position.

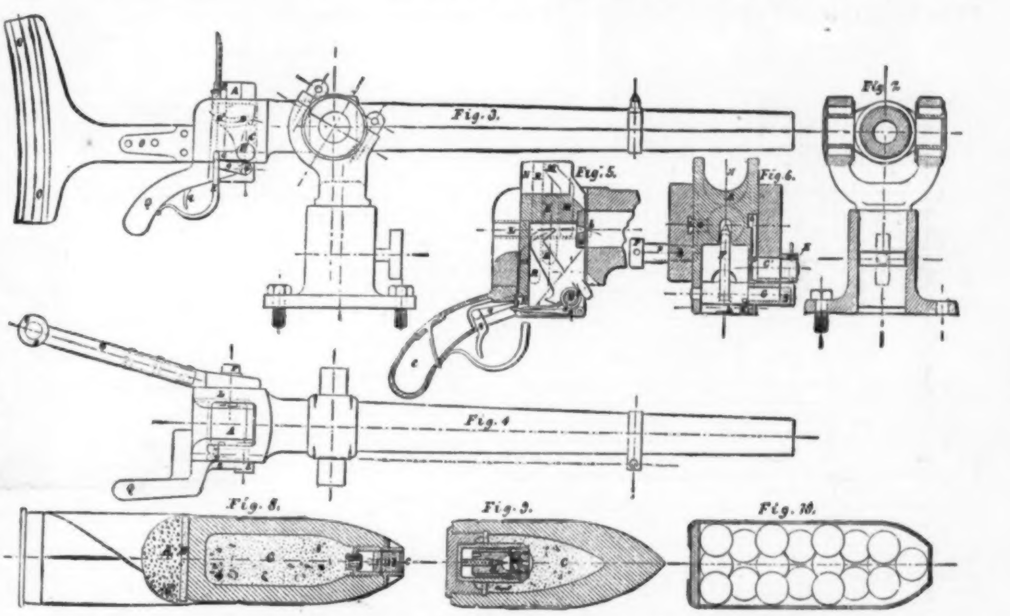
The ammunition used in this gun is illustrated by Figs. 8, 9, 10.

A very exhaustive series of trials was made last year by the French Navy Department at Gavre and Servan-Livry, the conditions imposed being that the caliber of the gun should be 1·85 in. (47 mill.), its weight from 440 lb. to 550 lb.; that it should fire a projectile of from 2·86 to 3·3 lb., and that the muzzle velocity should be about 1,900 feet. Three men were to be allowed to serve the gun, and the number of aimed rounds per minute, twelve, with a maximum of twenty-five unaimed rounds. It was expected that the steel shell should penetrate a steel plate $\frac{5}{8}$ in. thick, at a distance of 2,200 yards, and an elevation of 30 deg.

The first set of trials at Gavre consisted of five rounds fired at a range of 5,400 yards. Cast shell were used at the target, which was of oak timber 11·8 in. thick. The first, second, and third rounds were with blind shell, and the fourth and fifth with loaded shell. In the fourth round the shell passed through the target, and exploded close to it; the fifth shell fired also passed through, and exploded six feet beyond. In the second set of tests an oak target $15\frac{3}{4}$ in. thick was used. It comprised one round with a range of 4,375 yards with blind shell; two rounds of 3,450 yards range with blind shell; and one at the same range with loaded shell; all these passed through the target, and traveled for some distance beyond, and two rounds at 2,650 yards with loaded shell which passed through and burst at the back of the target. In the third series an oak target $19\frac{1}{2}$ in. was used. At this one round was fired with blind shell at a range of 4,375 yards, the result being a penetration of 11 in. beyond the base of the shell. Three rounds were fired at a range of 3,450 yards with blind shell, two of which penetrated. Finally two rounds were fired with loaded shell, both of which penetrated.

In a similar set of trials against iron targets, better results were obtained, due of course to the lower resistance of the metal.

Lastly, as illustrating the efficiency of these guns to repel torpedo attack, we may refer to trials also conducted at Gavre. The targets represented the bow and transverse bulkheads of a first-class torpedo boat, as far aft and including the front of the boiler. In the first round a loaded steel shell was employed, the range being 510 yards. The projectile did not explode, but it pierced the bow plate and three bulkhead plates, being then deflected upward, and falling 1,100 yards beyond the target. In the second round, loaded steel shell was also used, with a range of 765 yards. The projectile pierced the bow plate, and exploded just forward of the first bulkhead, tearing two holes in it. The fragment passed through, making twenty one holes in the second bulkhead, nine holes in the third, twelve holes in the fourth, two holes in the fifth, while the target representing the end of the boiler was penetrated by one of the fragments of the shell. —*Engineering*.



THE HOTCHKISS RAPID-FIRING GUN AND AMMUNITION.

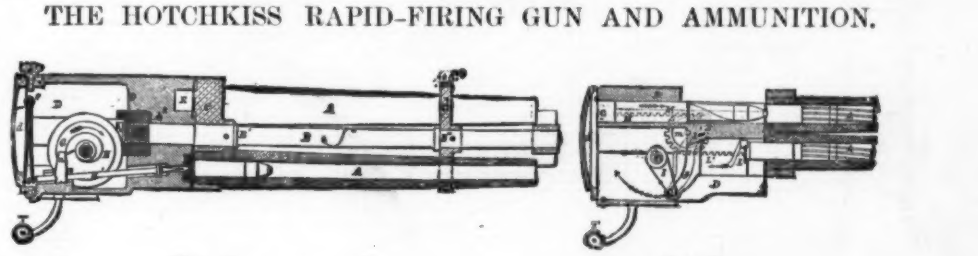
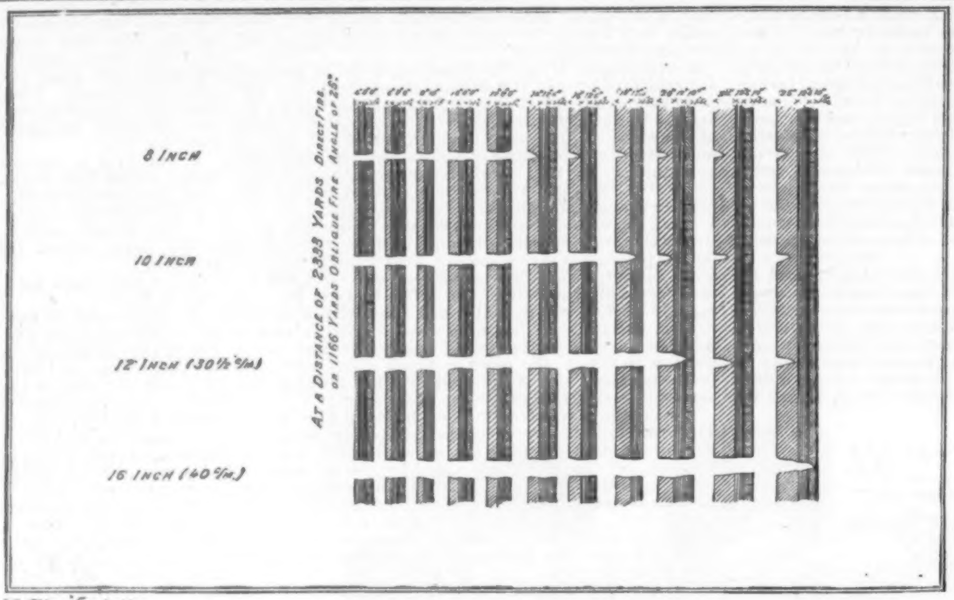


FIG. 11. FIG. 12.

THE HOTCHKISS REVOLVING CANNON.



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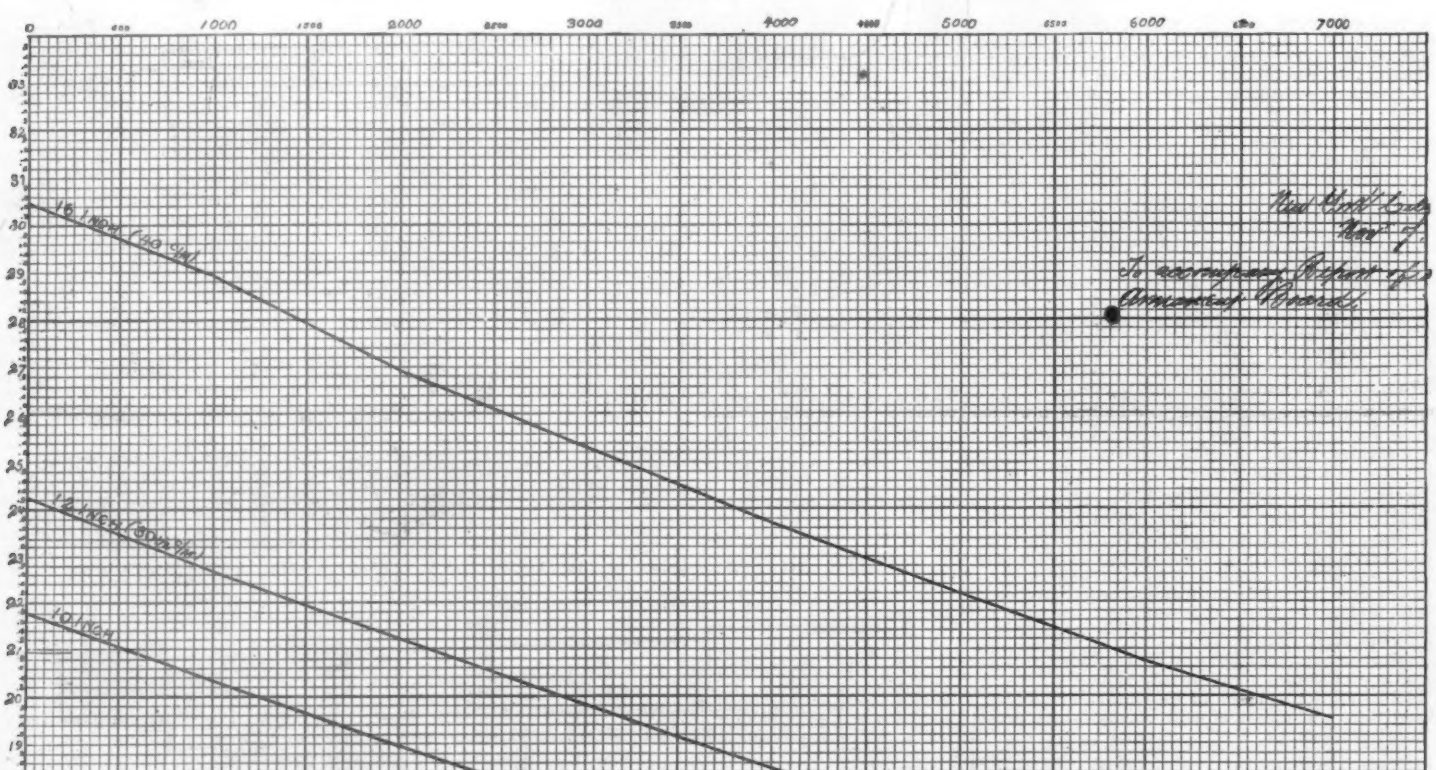
PENETRATING POWER OF HEAVY GUNS INTO ARMOR OF VARIOUS THICKNESSES.—FROM THE REPORT OF THE GUN FOUNDRY BOARD, 1884.



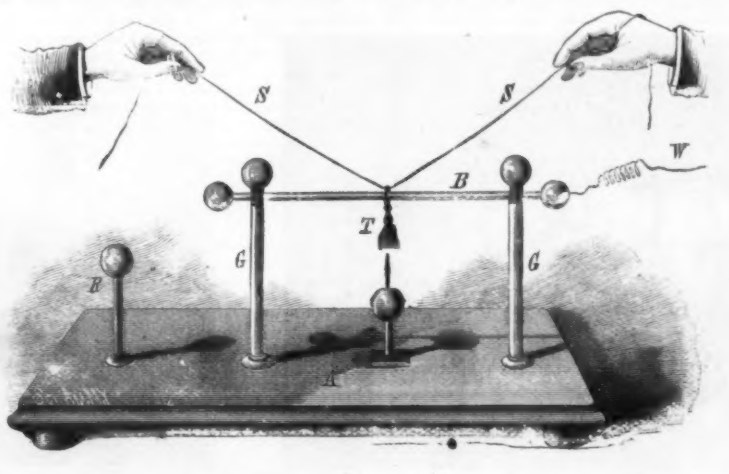
RANGE AND PENETRATION OF ARMOR OF HEAVY GUNS.—FROM REPORT OF GUN FOUNDRY BOARD, 1884.

EXPERIMENT ILLUSTRATING DISCHARGE OF ELECTRICITY FROM CLOUDS.

MR. LOUDON gives the following pretty experiment in the *Colliery Guardian*. It illustrates some of the phenomena of thunderstorms.

In the engraving, A is the base of the instrument, made of wood and brass. G G are glass legs supporting an arm of brass, B. The cloud is here represented by the moving tassel, T, pulled backward and forward by the strings of silk, S S. O is a ball provided with a point or lightning conductor. This ball is not insulated, that is, not supported by a glass leg. W is a wire leading to an electrical machine. On working the machine, electricity is spread over the arm, B. The tassel consequently diverges, owing to each filament being charged with like electricity. On drawing the tassel (cloud) over the lightning conductor, O, an opposite kind is given off at the point, and neutralizes the cloud, and the leaves or fibers collapse. If we were to wholly detach the tassel and work the machine till we raised a large envelope of electricity around the arm, B, a vivid flash of light (lightning) would pass to uninsulated conductor, R. If the ball, O, was not provided with a point, on moving the electrified tassel along the arm, B, it would not collapse on passing the ball, except that a faint spark was given off. If this spark took place, you have what often happens in nature.

Persons ought never to stand near a tree nor a house nor even a building provided with lightning conductors, for shelter. My reasons are these: Wood is a poor conductor, masonry worse, and if buildings provided with these conductors are not what they ought to be, they only invite destruction.



ILLUSTRATING DISCHARGE OF ELECTRICITY FROM CLOUDS.

APPARATUS FOR DETERMINING THE ELECTRIC CHARGES OF FALLING RAIN.

WHEN it was demonstrated by Benjamin Franklin that thunder clouds were masses of watery vapor charged with electricity, the conclusion was very natural that the rain falling from such clouds might possess the same charge, and the electricians of a former generation contrived apparatus to prove this and to estimate the amount of the charge. In consequence of the advance of electrical science and the multiplicity of various pieces of novel apparatus, the old contrivances are now nearly forgotten, but our attention has been called to this subject by the recent suggestion that the ignition of petroleum tanks, now so alarmingly frequent, may sometimes be caused by rain from a thunder cloud.

APPARATUS FOR DETERMINING THE ELECTRIC CHARGES OF FALLING RAIN.

It may, therefore, be well to give to the readers of the SCIENTIFIC AMERICAN an engraving of one of these pieces of apparatus as it was in use nearly a century ago by investigators of atmospheric electricity. It consists of a globe, *g*, of brass wire attached to a conducting wire, *h h*, which passes through a long glass tube, *k l*, supported by an insulating stand, *c*, placed on the window sill, *b*, and a few cords, *d*, attached to the upper sash, *e*, the lower sash, *a*, being raised. The end of the wire is provided with a brass ball, *m*, reaching over a table, *t*, on which a gold leaf electrometer or any other equivalent apparatus may be placed, which, being brought into contact with, or even in the vicinity of, the charged globe, *m*, will indicate the electric charge of the rain.

Experiments with this apparatus have shown that the drops of occasional showers are almost always more or less charged with electricity, and that it is only totally absent during foggy, moist days and rain storms of long duration; that, on the contrary, sudden rainfalls after a clear spell are always charged, and that, as was expected, the strongest charges are obtained during thunder storms. Even traces electricity have been occasionally observed without any rain falling, the air itself being charged.

DE LOCHT'S PANTELEPHONE.

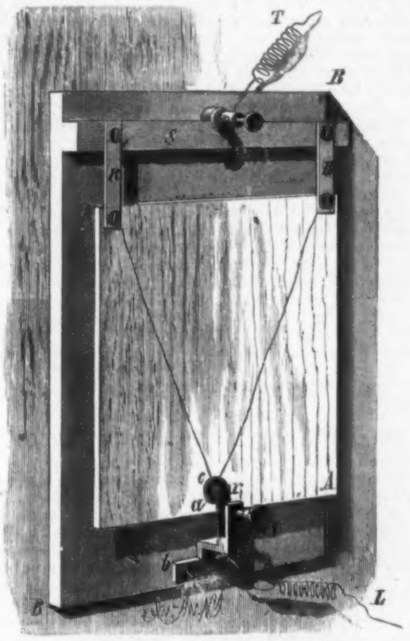
LEON DE LOCHT, Mining Engineer and Professor at the College of Mining, Mont St. Martin 49, Liege, Belgium, after several years' experimenting with a view of overcoming the defects of the best telephones in use, and after the invention of one or two forms of apparatus, which have been the subject of patents in various countries, has finally perfected an instrument which he calls the pantelephone.

This apparatus is a microphonic transmitter which is sensitive to sonorous vibrations emanating at a great distance. It is capable of transmitting words spoken at forty-five feet from the apparatus to a distance of several miles through the medium of receiving telephones. The pantelephone, which is extremely simple, is composed essentially of a movable plate carrying a carbon contact, which presses against a disk of carbon or metal—silver or platinum.

Referring to the accompanying cut, the plate is seen figured at AA. It may be of aluminum, sheet iron, steel, brass, mica, cork, or of any substance whatever that is capable of being formed into plates of large superficial area, while at the same time possessing the requisite amount of lightness. It is preferable that its form should be rectangular, fifteen centimeters square in size, and, when made of metal, two to three tenths of a millimeter in thickness. It should be as inflexible as possible, and not liable to bend out of shape through the influences of temperature and humidity. It is suspended by two small very flexible steel springs, R R, from a support, S, which is perfectly straight and stands out from the fixed plate, B B, forming the framework of the apparatus. To the middle of the lower end of the plate is riveted or soldered a small carbon disk, *c*, which, when the apparatus is in a vertical position, rests against a small piece of silver or platinum fastened to the end of a short and somewhat inflexible spring, *r*, the latter being fixed by means of a screw, *v*, to the copper support, *bb*. By means of a thumb screw, V, passing through the support, the contact of the carbon, *c*, with the piece, *a*, may be regulated at pleasure.

The pantelephone is placed in the circuit of a voltaic pile in such a way, for example, that the current entering at L proceeds to the support, *bb*, and from thence through the spring, *r*, to the contact, *a*, then to the carbon, *c*, and through the plate, A A, to the springs, R R, and leaves the apparatus at T.

There are other and secondary details of construction by means of which the inventor is enabled to so regulate the apparatus as to insure of the greatest sensitiveness and of the best possible performance. There are certain arrangements employed, too, to deaden and stop all noises which might arise from tremors of the earth, or from the shaking of the wall to which the apparatus is attached. It is claimed that the pantelephone, when once properly regulated, is not liable to get out of order; and, moreover, that the expense attending the use of the system is insignificant, since the apparatus under proper conditions requires for its making only the electromotive force of a single voltaic couple. The instrument transmits all sounds, articulate or inarticulate, which reach it, through the medium of either solids or the air. It is inclosed in a box (which may be made as ornamental as desired) in such a way that its sensitiveness to sonorous vibrations is in no way impaired.



DE LOCHT'S PANTELEPHONE.

MILITARY TELEGRAPH.

USUALLY in opening up a country, the telegraph precedes the railway, but for obvious military necessities the line of telegraph from Saukim to Berber can only proceed concurrently with the railway, which latter has had to wait upon the military advance. The most rapid system of constructing and maintaining such a telegraph line is the first necessity, and for this purpose the War Office has adopted Messrs. Siemens Bros.' latest form of patent telegraph pole, which is erected upon the dwarf pile system patented by Messrs. Le Grand and Sutcliff, of London. This dwarf pile is designed for the erection of many kinds of structures, among which railway signal posts may be mentioned, for which it is remarkably well adapted; but it seems to lend itself most peculiarly to the erection of telegraph poles, for which purpose nothing hitherto introduced appears in any way to approach it; and recognizing its importance Messrs. Siemens Bros. and Co. have within the last few years taken up the exclusive license in connection with telegraphs, and have furnished them for the erection of many thousands of telegraph poles in different parts of the world. Fig. 1 of the accompanying illustration shows one form of Le Grand and Sutcliff's patent pile, together with the rammer by which it is driven into the ground. The pile is of cast iron, and is slightly taper. The rammer is of wrought iron, and forces the pile into the ground by delivering its blow just over the point. Fig. 2 shows the pile driven into the ground with

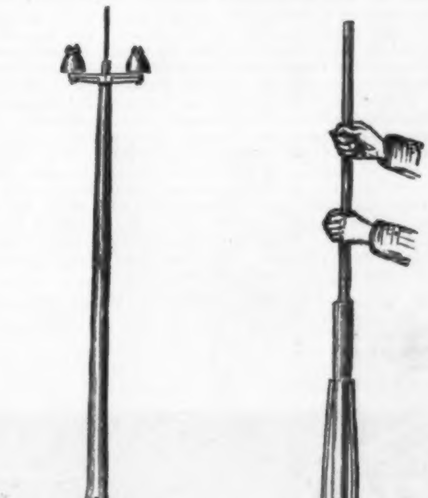


FIG 2 FIG 1

Messrs. Siemens Bros.' patent taper iron tubular pole attached to it. This is effected in a most ingeniously simple manner. The pole is slit up for a few inches from the bottom, which enables it to readily fit itself on to the taper top of the dwarf pile, and a wrought iron ring driven over securely fastens the pole to the pile. The whole operation of erecting a pole in ordinary ground is but the work of a few minutes for two men, the time occupied in driving the pile being from two to three minutes. Thus it is found in actual practice that two men can erect more poles in a day's work than formerly occupied ten men on the old plan of digging holes and ramming in the ground; while it is also found that the full complement of wires can immediately be attached, as the pole is at once as firm as under the excavation system it would be after the ground has had a twelvemonth to consolidate. In addition to the very great saving in time, labor, and plant, the facility of transport is equally marked, for one camel can walk away with four 16 ft. poles and piles complete, and thirty camels can thus take six miles of line. The Imperial Brazilian Telegraph lines are nearly exclusively carried on these poles, which will stand comparison with the best lines in existence. As a proof of this, on December 14, 1884, the director of the Imperial Telegraphs carried on direct communication between South Luiz, *via* Riode Janeiro, Montevideo, and back to Rio de Janeiro—a distance of 6,045 miles. A message of thirty-three words took 5¼ minutes in transmission, and during this time a severe thunderstorm was raging in the Province of Espirito Santo, and rainy weather in the south of Brazil.—*The Engineer.*

JABLOCHKOFF'S AUTO-ACCUMULATOR.

THE well-known inventor of the electric candle has recently made public another interesting and ingenious invention. The principal features of the present Jablochkoff cell, which has three electrodes, and which the inventor calls the auto-accumulator, are, says *Engineering*, its lightness, its low cost, the absence of liquids and of smell—qualities seldom found combined in any battery. The following will explain its construction and mode of working: In a leaden vessel of any form are placed fragments of metal, such as iron, zinc, etc. Under the influence of humidity, this will form a couple, and the lead will be polarized. If above these metallic fragments is placed a semi-conductive material, well moistened, such as sawdust, cloth, etc., and if over this are sticks of charcoal, made very porous so as to give free access to the air, a current will be produced when the leaden recipient and the carbons are placed in circuit. In this way a cell is formed with three electrodes, one of which oxidizes, a second becomes polarized, and the third forms a positive pole with the second, the two first forming a couple with a constantly closed circuit. This general description will be clearer if we describe how M. Jablochkoff practically connects the cells. Several methods have been devised, the most ingenious and practical of which is as follows: A small rectangular vessel, measuring 4 in. on each side, is formed of carbon, which is impregnated with paraffin to prevent the air from penetrating, and producing polarization. In this vessel are placed a number of metal fragments—zinc clippings, pieces of iron, etc. On these is laid a thickness of wood sawdust or a piece of coarse cloth impregnated with a solution of chloride of calcium, which maintains a constant humidity. Lastly, on this are placed, parallel to each other, eight hollow sticks of carbon. The whole forms a cell 4 in. square, and about 1 in. high. Any desired number of these cells can be coupled by piling them one on top of another between four guides, in the same way as a Volta pile. The bottom cell rests on a metal plate, forming one of the poles. The top cell is covered with a plate of carbon to which a terminal is fixed, and this forms the other pole. As will be seen by this arrangement, the lead is replaced by carbon, which makes the cell lighter, and more easily cleaned. This latter operation is very simple, and is effected by washing the cell in water, so as to remove the metallic chloride formed, and plunging it afterward in a bath of chloride of calcium, when, after drying, the cell will remain fit for work during twenty-four hours. We have said that this auto-accumulator will work with any oxidizable metal. In practice M. Jablochkoff has confined himself to three principal bodies—iron, zinc, and amalgam of sodium. The following results have been obtained by the inventor with these:

	Electromotive Force for each Cell. Volts.	Internal Resistance between 0·25 and 0·50 Ohm.
Iron	1·1	" "
Zinc	1·6	" "
Sodium amalgam	2·2	" "

Under these conditions the price per horse-power per hour would be 0·05 franc for iron, 0·25 to 0·30 franc for zinc, and 1·25 francs for sodium amalgam, assuming the cost of iron per kilo. to be 5 centimes, that of zinc 0·5 franc, and that of sodium 5 francs the kilo., a price which will soon be reached. It will be seen that iron is by far the most economical, although its efficiency corresponds to only one-fourth the amount of work done by the sodium. This latter recommends itself on account of its extreme lightness; a cell containing 60 grammes of sodium amalgam placed in a very light leaden receptacle producing 6 watts of electric work. Besides, where this is employed, the use of chloride of sodium is rendered unnecessary, because the soda liberated suffices to maintain the humidity of the cell. It would therefore appear that the auto-accumulator charged with iron forms a very light battery, since with the standard dimensions of 10 cent. by 10 cent. by 2·5 cent., and with a weight of less than half a pound, an energy of two watts can be obtained. A battery of five of these cells in tension would therefore give 10 watts, and would weigh about one kilogramme. It is very economical, since very cheap materials are obtained; it is easily managed, quickly cleaned, without smell or danger, and occupies very small space. If all these advantages claimed by the inventor are realized, this battery marks a great and real progress; and should be found capable of fulfilling many purposes for which the ordinary types of cells, with their acid liquids and deleterious fumes, are quite unsuited; while if the highly favorable estimate that has been formed of the cost of working be even approximately borne out by practice, it is evident that a great saving will be effected in the chemical production of electric energy. In any case its lightness and small bulk will also adapt it for use in portable lamps for domestic purposes.

ELECTRIC LIGHT MACHINERY.

THE engraving above illustrates the arrangement of the electric light shed at the Inventions Exhibition, London, and gives some idea of the great amount of power required to light the grounds and buildings. The engines and boilers are by Messrs. Davey Paxman & Co., of Colchester. The dynamos are by many different makers, and will be described in due course.

ELECTRIC LIGHTING OF CARRIAGES.

IN the accompanying engravings we illustrate an arrangement that has been devised by Mr. Aboilard for lighting carriages. We here see an elegant coupe whose lamps contain two incandescent electric lights that operate continuously. There are also two other lamps that may be used at intervals. One of these is placed inside of the carriage and the other on the horse's head. The conductors are hidden in the harness.

The apparatus necessary to light carriages consist, for each incandescent lamp, of four small accumulators contained in a box, A A, 8 inches high, 12 inches long, and 4 inches wide, placed under the coachman's seat. These accumulators are capable of actuating a small 5-candle incandescent lamp for six consecutive hours. This period is further increased when the accumulators are operated at intervals, as in the case of the small lamp within the carriage. Every time the occupant leaves the carriage the circuit may be broken. This lamp, as well as the one on the horse's head, is connected with accumulator boxes of small size placed under the seat of the carriage.

In the external lamps Mr. Aboilard has substituted for the ordinary candle a wooden dummy that carries at its upper extremity a lamp-support, and at its lower part two terminals to which are affixed the wires that come from the accumulators. The usual spiral spring serves here for holding the dummy against the aperture left in the interior for the exit of the flame. This arrangement, in case of accident, permits of instantly replacing the dummy by an ordinary candle, without disturbing the arrangement.

This system of lighting is not only adapted to carriages, but might also be applied to the wagons that serve for carrying collections of novelties, for the purpose of attracting the attention of passers-by.—*La Nature.*

FIG. 1.—CARRIAGE LIGHTED BY ELECTRICITY.

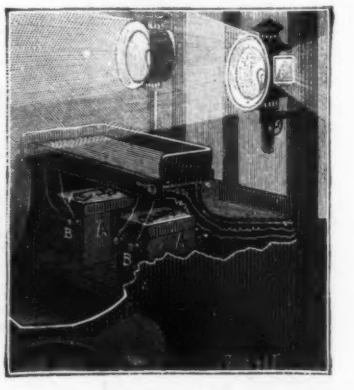


FIG. 2.—ARRANGEMENT OF THE ACCUMULATORS.

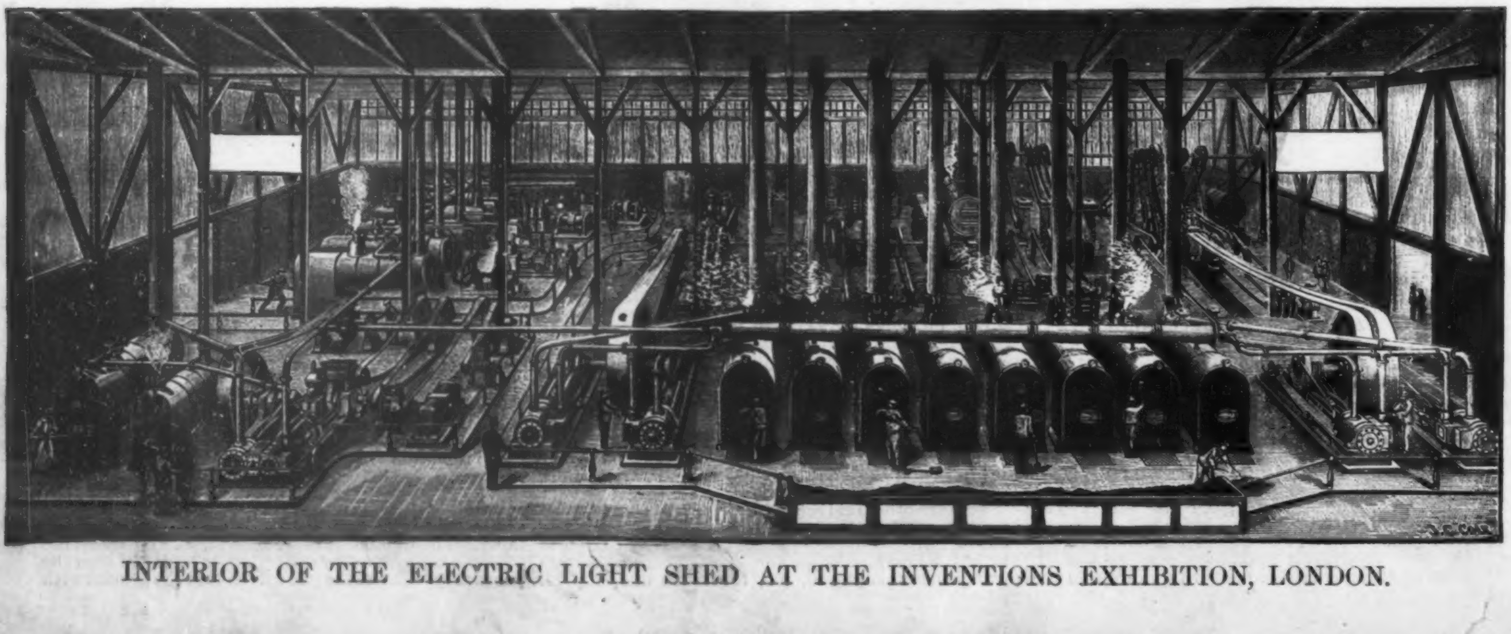
THE DISTRIBUTION OF ELECTRICAL ENERGY BY SECONDARY GENERATORS.*

By Mr. J. DIXON GIBBS.

THE remarkable results obtained during the last few years from the production of electrical energy and its application to lighting purposes, as well as to the transmission of mechanical power, have naturally brought into prominence the great problem of the distribution of electricity. In a complete system of electrical distribution, it is necessary that electrical energy in all its forms should be at the disposal of individual householders, whatever the service they may require it to perform; that is to say, if light is desired, currents should be available at will for feeding every type of lamp, whether arc or incandescent. If mechanical power is required, motors should supply it; while currents suitable for electro-chemical purposes should be obtainable with equal facility. The distribution should be over a large area, central stations being preferably situated in the outskirts of towns at a distance from the area to be supplied. Where water power exists it should be utilized, or, if steam power is used, a site should be chosen in proximity with water so as to secure the economy in fuel effected by the employment of condensing apparatus.

It is scarcely necessary to remark that nothing hitherto done in the way of street lighting or of lighting large establishments, such as theaters, hotels, and public buildings, by means of machinery on or near the premises, can be claimed to constitute a distribution of electrical energy. The same may be said of the transmission of a given force to a single point. This is not a distribution of mechanical power. Gas and water companies do not set up separate works for the supply of special consumers, but from central stations distribute to all consumers in conformity with their several requirements. In order to arrive at the results just de-

* Paper read before the Society of Engineers, April 13, 1885.



INTERIOR OF THE ELECTRIC LIGHT SHED AT THE INVENTIONS EXHIBITION, LONDON.

scribed as necessary to a complete system of electrical distribution, the following conditions are essential:

1. Every receiving apparatus must be supplied with its proportion of electrical energy, so that it may act independently of the others and without affecting them.

2. The regulation must be automatic, instantaneous in its action, and require no attention.

3. The regulation must be of such a nature that the generating dynamo machine shall produce each moment the exact amount of electricity necessary to supply all the apparatus in action.

The chief difficulty in realizing these conditions has been that the intensity and E. M. F. of an electric current being always exactly determined, the uses to which the current can be put are necessarily limited to feeding apparatus of a given resistance and of an electrical capacity in harmony with the quantity of available electricity, from which it results that by means of a given current it is only possible to employ apparatus of consumption of identical construction, that is to say, connected together under certain conditions of resistance that must be maintained constant.

The author need not review the various systems, more or less ingenious, which have been invented during the last few years, with the result, not of solving, but of going round the difficulty, for in the interesting lectures recently delivered by Professor Forbes before the Society of Arts, the mechanism of all these combinations has been ably explained. It seems, however, to have resulted from the facts adduced in these lectures:

1. That the future of electrical distribution lies in the direction of the employment of currents of high potential and small quantity, requiring conductors of small diameter.

2. That the employment of an apparatus by means of which the factors of the initial energy can be transformed to suit the requirements of each consumer is essential to the solution of the problem which we are discussing this evening, and the secondary generators under review are such transformers. They are known as the Gaulard-Gibbs secondary generators. The phenomena of induction which have immortalized the name of Faraday are utilized in these instruments. Numerous predecessors have certainly conceived the idea of utilizing secondary currents localized and of different kinds, but coming later in this path of research the inventors of the secondary generators have labored under more propitious circumstances, because results already arrived at have enabled them to produce these phenomena under such conditions that their employment has been rendered absolutely practical and economical. This consideration certainly inspired them with the courage to pursue with perseverance those researches to which their predecessors had given but passing attention.

However this may be, the present inventors have regarded the employment of these phenomena from a purely industrial point of view. Their first thought after having experimentally verified the actual transformation of primary electrical energy into electrical currents of different kinds, and capable of being applied to every practical purpose, was to make a careful analysis of the phenomena observed. They were thus able to determine the special conditions under which the primary and secondary circuits would yield the highest effective and most economical return for the energy expended; they arrived at the conclusion that the two circuits, inducing and induced, must have the same mass of metal and a position absolutely symmetrical with the common magnetic field. Since it is upon the determination of these conditions that the invention of the secondary generator is based, it may be interesting to know that these conditions, which are a *sine qua non* of an economical return, have never been previously determined.

But it was not sufficient to determine philosophically what the industrial conditions should be; it was also necessary to realize them practically. The inventors accordingly constructed their apparatus with a sufficient number of spirals to produce the required practical E. M. F. by means of a cable formed of an inducing circuit of low resistance surrounded parallel to its axis by forty-eight wires composing the induced circuit, the sum of the sections of which was equal to the section of the inducing circuit. By means of this arrangement the theoretical conditions already alluded to were approximately fulfilled, since the mean distances of the induced circuits from the magnetic field were equal to the distance of the inducing circuit from the same magnetic field. Further, it was easy to group the extremities of the secondary wires so as to give to the factors E.I. of energy the different values required according to the work to be done. These apparatus served during five consecutive months without interruption to light with arc and incandescent lamps five stations of the Metropolitan Railway, one apparatus being placed at each station. The primary circuit in which they were placed was composed of a single wire 15 miles in length and $\frac{1}{8}$ of an inch in diameter. This primary circuit was metallically closed throughout its entire length with the terminals of the dynamo machine at Edgware Road. The results as regards effective work formed the subject of a report by Dr. Hopkinson, the conclusions of which were perfectly satisfactory, and are too well known to require repetition.

The anticipations of an economical return having been thus fulfilled, the next step was to seek the most simple and practical methods of applying economically the principle upon which the construction of the apparatus reposed. These researches led to the formation of the inducing and induced circuits by means of copper disks superposed and furnished with ear pieces for the purpose of connecting them together. This arrangement, which allows of the juxtaposition of the two circuits, has also the advantage of permitting the employment of any insulating material that may be found to give the best results. The simplicity of this method of construction is obvious; the weight and size of the apparatus are remarkably small in relation to the work it is capable of performing.

The apparatus is identical in form with the generators exhibited at Turin. One column of the generator is shown at Fig. 1 of the engravings. Between the supports, S, S, fixed on a wooden foot, the primary and secondary disks, P, are arranged as a column. The eyes, which serve to connect each two consecutive disks, are visible in the figure. Z to Z are the clamps for introducing the primary current; H is the handle for connecting or disconnecting the apparatus. The core of soft iron wire, K, serves for increasing or diminishing the production of the secondary current. The plates visible on the front bar, C, contain the connections for the secondary currents, which may be derived at pleasure for arc or glow lights, or for both simultaneously.

It is worthy of remark that in these apparatus the actual resistances of the inducing and induced circuits are kept as low as possible, so as to render the work expended in the interior circuits very small in proportion to the work available in the exterior circuits. As an example, take the instrument we have before us; it is intended to supply in the exterior circuit an effective work of 750 watts under the influence of a primary current of 12 amperes—the total resistance of its two circuits, induced and inducing, is $\frac{3}{10}$ of an ohm, so that $12^2 \times \frac{3}{10}$ watts represents the work absorbed by the apparatus, and, consequently, useless; thus the theoretical loss of energy resulting from the interposition of these apparatus is $\frac{43\cdot2}{750}$, or $5\frac{3}{4}$ per cent. Nevertheless, when the inventors announced an effective return of 90 per cent., many doubts were expressed in consequence of the unfavorable results hitherto obtained from researches in the same direction; these doubts were really testimonies to the novelty of the results; it remained only to demonstrate conclusively the truth of these results. The authority of an eminent electrician had been insufficient to carry conviction to every mind.

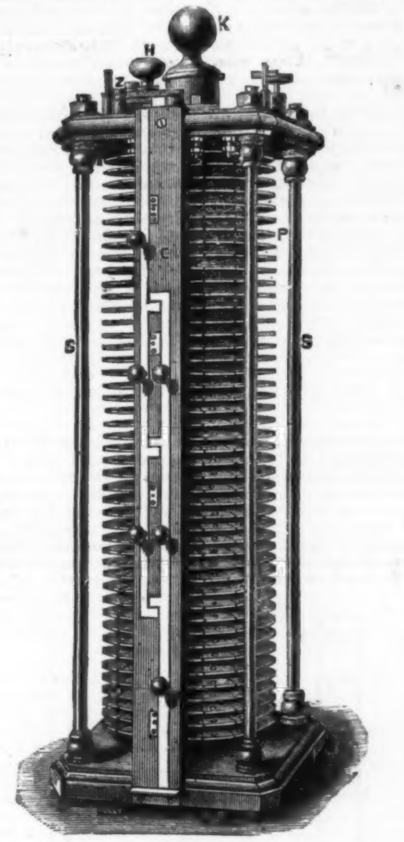


FIG. 1.

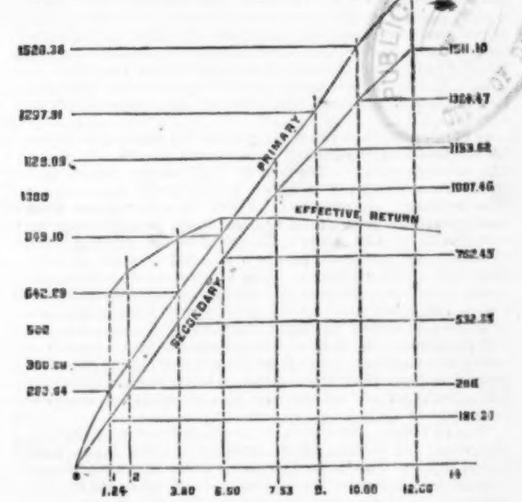


FIG. 2.

THE GAULARD-GIBBS SYSTEM OF SECONDARY GENERATORS.

An exceptional circumstance, however, enabled the inventors to determine definitely, without room for further question, the accuracy of their assertion.

In the month of January, 1884, the Italian government offered a grand prize of 10,000 fr., to be competed for internationally for the most important advance made in the transport of electrical energy to a distance, and invited other governments to name representatives who should constitute a jury for deciding the question. The Italian government was probably influenced in taking this step by the conviction that the industrial development of Italy would be largely aided by the prompt utilization of the vast natural forces in which the country abounds. The jury was composed of M. Tresca, Membre de l'Institut de France, honorary president; Professor Ferraris, acting president; M. Wattmann, Rector of the University of Geneva; Professor Voit, of Munich; Professor Webber, of Zurich; Professor Roiti, of Florence, Member of the International Commission for the Determination of the Ohm; Professor Kittler, of Darmstadt; Professor Cossa, of the School of Engineers at Turin; Professor Farini, of Milan, etc. Professors Voit and Kittler were the gentlemen deputed to take electrical measurements at the Vienna and Munich electrical exhibitions.

Practical experiments of the distribution of electrical energy by means of the secondary generators were made under conditions which M. Tresca, in the name of the international jury of the Turin Exhibition, communicated to the Academie des Sciences de Paris, in terms of which the author will read a translation. The original was published in the *Lumiere Electrique* of October 18, 1884. It runs as follows: "An International Electrical Exhibition is now being held at Turin, in connection with which an important prize is offered by the Italian government and the town. I am charged by my colleagues of the jury of this exhibition to bring to the notice of the Academie the following facts: Messrs. Gaulard and Gibbs have established at the exhibition, the station of Lanzo, and the intermediate stations, a circuit whose length, including return, is 80 kilometers by means of a bronze chrome wire 3·7 millimeters in diameter without covering. This wire carries an alternating current produced by a Siemens electro-dynamic machine of the 60 horse-power type in such a way that the current can be simultaneously utilized for different modes of lighting, whether at the exhibition, or at the Turin station, or at the Lanzo station, or at the intermediate stations, by its transformation at each point of the two factors constituting its energy by means of the secondary generators of the new type, shown by Messrs. Gaulard and Gibbs. On September 25 we verified the simultaneous regular working.

"1. At the exhibition of the following apparatus, which had to be necessarily supplied with very different potentials—nine Bernstein lamps, one sun lamp, one Siemens lamp, nine Swan lamps, and five other Bernstein lamps situated at a small distance.

"2. At the Turin Lanzo station, 10 kilometers away, thirty-four Edison lamps of sixteen candles, forty-eight of eight candles, and a Siemens arc lamp.

"On September 29, the experiments were still more conclusive, the system being extended to the Lanzo station, 40 kilometers distant, by the perfectly regular action of twenty-four Swan lamps of 100 volts. The numerous transformations required by the variety of these different methods of lighting are effected with accuracy, and, although we are not able to give the exact figures, it is perfectly demonstrated that the secondary generators may be considered, at all events within certain limits, as transformers giving a relatively large return of the energy of alternating currents. The actions of lighting and extinction are effected without any disturbance (of the other lights), and by means of simple commutators. The principal object of this communication is limited, however, to testifying to the complete success of a distribution of different modes of lighting over an (effective) distance of 40 kilometers. The importance of the realized fact alone demands that it should be fixed by a precise date, but it should be borne in mind that we are not dealing here with the transport of mechanical power."

More than 300 Italian engineers and architects who had witnessed the experiments, assembled for the 1884 congress, passed a resolution of which the author will read a translation: "The fifth congress of Italian Engineers and Architects cannot ignore the great importance of the experiments now being made at Turin by means of the Gaulard and Gibbs secondary generator, and, having examined the working of such a system of distribution, record the hope that the government, the corporations of towns, and manufacturers will patronize this system, and that the expectations which five months of trial on the Metropolitan Railway, the experiments at Turin, and the sound scientific conceptions upon which the system is based have raised in the field of science and industry, may thus be realized."

The measurements taken by means of the electrometer of Mascart of the effective return of the secondary generators are shown by the curves on the diagram Fig. 2. In taking for abscissæ the resistances introduced in the secondary circuit, and for ordinates the primary and secondary work, it will be seen that the progression, at first increasing, arrives at its maximum between the resistances of 6 and 10 ohms, which are the resistances under which the apparatus works normally; but these measurements having been considered by some members of the jury not absolutely free from theoretical objections, a commission was appointed by the jury, composed of Professors Webber, Voit, Roiti, and Ferraris, to prepare a calorimeter, by means of which Professor Ferraris carried on his experiments during seven consecutive days, and arrived at the conclusions which formed the subject of a special report, which is very voluminous. The conclusions of this report are condensed in the table of which the following is a copy, and which gives an average practical return [column (N)] of 94 per cent. when the apparatus worked under the conditions for which they were constructed.

In the annexed table are shown the theoretical and

R	M	N	(N)	R	M	N	(N)
0·28	0·500	6·000	0·00	22	0·976	0·963	0·95
2	0·876	0·753	0·74	24	0·976	0·964	0·95
4	0·933	0·867	0·86	26	0·975	0·964	0·95
6	0·956	0·911	0·90	28	0·975	0·965	0·95
8	0·962	0·928	0·92	30	0·975	0·966	0·96
10	0·967	0·940	0·93	32	0·974	0·966	0·96
12	0·971	0·948	0·94	34	0·973	0·965	0·95
14	0·973	0·954	0·94	36	0·973	0·965	0·95
16	0·974	0·957	0·95	38	0·972	0·965	0·95
18	0·975	0·959	0·95	40	0·971	0·964	0·95
20	0·975	0·961	0·95				

practical coefficients of the return from a secondary generator coupled in tension, calculated in the following manner, for a series of resistances of the secondary circuit. In column R the values of the total resistances of the secondary circuit vary from 0·28 to 40·0 ohms. In column M are shown the theoretical values of the coefficient of the total return. In column N are shown the values of the coefficient of the exterior theoretical return, and in column (N) the values of the coefficient of the exterior practical or effective return.

Now that the secondary generator has been absolutely demonstrated to be a perfect transformer of the energy of alternating currents, it only remains to the author to examine whether the conditions under which these instruments act are in perfect accord with the conditions laid down at the commencement of this paper for the solution of the problem. In order to thoroughly understand that this is so, let us suppose that we have to distribute 10,000 glow lamps, 200 arc lamps, and 200 mechanical horse power in varying proportions, over a circuit 15 miles in length. The author adopts these figures because they represent somewhere about the average requirements of the future. With the aid of the secondary generators this distribution would be effected in the following manner:

The initial electrical work would be produced by four alternating current dynamo machines, of the Siemens model, for example, supplying 100 amperes and 3,000 volts each. This work would be distributed over four distinct circuits, metallically closed with the terminals of each dynamo, and formed of a cable having a diameter of one centimeter only, connected with the secondary generators, one of which would be placed in the house of every consumer. The form and size of these secondary generators would necessarily be proportioned to the quantity of work required of each one respectively. It may be remarked here that the secondary generators, fed by an electrical quantity which is constant, develop on the current which feeds them a counter electromotive force which is proportionate to the work they develop in their external or secondary circuits. From this it follows that the quantity or ampere value of the primary current must remain fixed, whatever may be the number of secondary generators to be fed, and that the E. M. F. only of the primary current will vary according to the sum of the resistances set up by the number, more or less important, of the generators in action on the circuit. This result is automatically obtained by means of a regulator of intensity, which, placed in the primary circuit, acts upon the derivation of the exciting machine, by introducing variable resistances, so as to proportion the intensity of the magnetic field of the generating dynamo machine to the E. M. F. which it must develop in order to overcome the resistance opposed by the secondary generators in action.

It is necessary to remember that the work developed by the secondary generators depends absolutely upon the number of spirals of which each is composed, and the form of energy developed depends on the manner of grouping these spirals. From this it follows that each consumer may, as it pleases him, put his apparatus in action, and cause it to produce the special form of energy he wishes to employ without troubling himself about his neighbors. The most absolute independence of each apparatus, and an automatic proportioning of the work produced to the work expended, permit the realization by this system of the essential conditions already indicated for enabling a distribution of every alternating form of electrical energy in currents resulting from the phenomena of induction, which produce always, and necessarily, the alternating form of current.

The old ideas, attributing special danger to the employment of alternating currents, have been ably corrected by Professor Forbes, Dr. Hopkinson, and others; but it is worthy of remark that in an installation under the system the author is discussing—whatever may be the E. M. F. of the primary current, which, it must be remembered, circulates always in a closed circuit—the difference of potential between the terminals of the secondary generators will never be greater than that necessary for the lamps fed by them—that is to say, 100 volts or 50 volts, as the case may be. Nothing, therefore, short of culpable carelessness could possibly give rise to a condition of things presenting any danger whatever to the public.

If consumers required electrical energy only for producing light, a solution brought to this point would be as complete as possible; but the applications of continuous currents are too numerous not to render their distribution also desirable, and that with the same facility which, it has been shown, attends the distribution of alternating currents.

It has been already pointed out that the condition *sine qua non* of the practical and economical transport and distribution of electrical energy to a great distance is to give to the energy to be transported the form of small quantity and high tension, or E. M. F. But although the known types of alternating current dynamos adapt themselves with the greatest facility to the production of currents of the highest E. M. F., this is, unfortunately, not the case in regard to the collection of continuous currents of a higher E. M. F. than 2,000 volts. On this account the inventors of the secondary generators sought and found a means of redressing the alternating currents produced by their secondary generators. These currents, it will be remembered, have already, by transformation, a low E. M. F., that is to say, they are in the form most readily utilizable. On November 16 last, Professor Ferraris, president of the International Jury of the Turin Exhibition, witnessed the perfect redressing of a current produced by a secondary generator—this current had 16,000 changes of direction per minute.

The instrument for redressing an alternating current is composed of several electro magnets coupled in series and fixed on a cast iron frame, a similar number of electro-magnets attached to a movable frame turning on its axis, a redressing commutator fixed on the same axis, having as many changes of polarity as bobbins, and lastly of collectors receiving the currents. The alternating current enters by the fixed bobbins, traversing them in series; the point where the current leaves is attached to the brush which communicates with the commutator; the opposite pole communicates directly with the other brush. These brushes are so arranged that they can never come into contact with the same metallic pieces. If the apparatus is at rest, the movable electro-magnets are also traversed by the alternating currents; but as soon as the apparatus begins to work, the commutator inverts the poles of the movable electro-magnets. When the speed has reached the synchronism of the alternations, the current becomes continuous in the movable bobbins, and maintains the synchronism. It is necessary only to take a derivation on the collectors to have a continuous current.

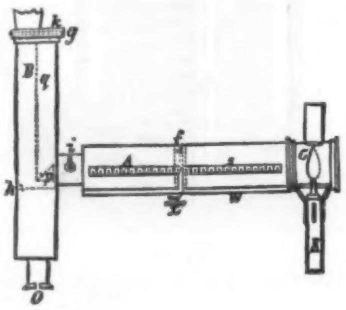
This instrument has, then, the property of taking under the influence of a very small alternating current a speed which is synchronic with the changes of direction of the current which feeds it. Thus, then, until it has been found possible to do important work with continuous currents of high E. M. F., the secondary generators will enable the distribution in all its forms, whether alternating or direct, whether of high or low potential, of electrical energy, over distances sufficiently great to enable the practical utilization of natural forces. The value of the progress thus realized has been officially recognized in Italy by a grand prize of 10,000 francs.

Besides installations in Italy and elsewhere, there is one now in course of preparation, of which the central station is situated in New Bond Street, which will doubtless be studied with interest. This installation will consist of the distribution of more than 5,000 lamps of various systems—the steam engines now being placed in position are of over 600 horse-power indicated, and have been manufactured by Messrs. Marshall & Company, of Gainsborough. The dynamos to be used are by Messrs. Siemens Brothers, and are the largest yet made by that firm; they have already been tested, and give most satisfactory results. An excavation of 6,000 square feet has been made under the Grosvenor Gallery, and in this space the machinery is being placed.

It may be interesting to mention that, pending the laying down of the large engines, a temporary engine of 30 horse-power nominal is driving two Siemens W dynamos coupled in parallel, which give a current of 24 amperes and 800 volts. This current traverses sixteen secondary generators of 2 horse-power each, which supply currents for 300 glow lamps distributed in the library and club at the Grosvenor Gallery, and in two adjoining establishments in Bond Street. When the satisfactory working of the permanent installation shall have been demonstrated, it is not unreasonable to expect that a wide extension of the application of electricity for the purpose of house to house lighting upon the principle described by the author will take place.

A NEW PHOTOMETER FOR DIFFUSED LIGHT.

PHOTOMETERS and photometry being prominent among debatable topics at the present time, it is well to take account of all suggestions for the improvement of photometrical apparatus; and therefore we lay before our readers the following abbreviated description, from the *Journal fur Gasbeleuchtung*, of a photometer designed by Dr. Leonhard Weber, of Breslau. The apparatus is made by the firm of Schmidt and Haensch,



of Berlin; and, according to the testimony of the designer, it is a very accurate and convenient arrangement. It belongs to the class of photometers in which a simple focusing serves, with the help of the susceptibility to light of the observer's eyes, to establish equality between the illumination of two neighboring plane surfaces. The best known types of this class are the photometers of Rumford, Ritchie, Bunsen, and Foucault, in which the focusing is arranged according to various methods. The special considerations upon which Dr. Weber has based his arrangement are: (1) The luminous impression is independent of the distance of a plane; or, in other words, the quantity of light received upon one and the same spot of the retina from a luminous plane is independent of the distance of the plane; or, again, if an observer regards the sun through a diaphragm at an invariable distance from his eye, the same brilliancy would be perceived, however near the sun might approach the observer. (2) The luminous impression is also independent of the angular inclination of the luminous plane with the normal line of vision. It will be noticed that it is a question here entirely of luminous planes such as are formed when a point or flame of light is caused to pass through any semi-transparent white screen, such as opal glass. The truth of these laws may be appreciated from the fact that we always see globes of opal glass, with gas-flames inside, as though they were plane disks. We cannot perceive their rotundity by reason of any diminution of illumination round the edges, where the substance of the glass is really farther removed from the eye; but they appear as plane disks of equal luminosity in every part.

The preceding illustration shows the essential features of Dr. Weber's apparatus. It consists of a tube, A, about 30 centimeters in length and 8 centimeters in diameter, blackened inside. It is held in a horizontal position by a stand not shown in the figure. At one end is a chamber, C, connected to it, with a bayonet joint, in which a standard candle, K, is introduced from the bottom, where it is held by a suitable holder. There is in the apparatus (but not shown in the figure) a slit for centering the candle-flame on a vertical line; and also one for observing the height of the flame against a scale placed behind it, and graduated to tenths of a millimeter. The regulation of the height of the flame is effected by revolving the candle in its holder. Inside the tube, A, is a frame, *f*, which holds a disk of opal glass. This frame is connected with a slide arrangement, W, capable of being moved backward or forward by a milled screw, *x*, and carrying a pointer indicating upon the outside millimeter scale, *s*, the position of the internal glass disk. In connection with the tube, A, is a second tube, B, pivoted at right angles to it, and capable of being secured in any desired position by the screw, *i*. In the figure it is drawn in a vertical position, for the purpose of showing it in plan; but it would in general be used in a horizontal position. When vertical observations are required, the arrangement as shown would be supplemented by an additional reflection-prism, for the convenience of the operator. Inside this tube, B, is a fixed prism, *p*, which occupies half the field of vision afforded by the eye-piece, O, and the diaphragm, *h*, and thereby gives the observer a view, on the right of the illuminated disk in the tube, A. The left side of the field of view is occupied by the direct sight of another opal glass disk at *g*, the light from which, when it is directed upon a luminous object, is prevented from striking the prism, *p*, by the fact of the tube, B, being divided longitudinally as far as the sharp edge of the prism by the blackened partition, *q*. The interference of other lights is shut off from the opal glass, *g*, by the conical protector, *k*. The eye is not concerned with finding the distance between either of the opal glass screens, *g* or *f*, and the diaphragm, *h*; because, according to the first law above stated, either of these luminous planes might be immovably fixed to the diaphragm itself.

The focusing of the apparatus is always done by simply directing the tube, B, upon the source of light the intensity of which is to be measured, and then, by turning the screw, *x*, the screen at *f* is placed in such a position with regard to the standard light in C that the two halves of the luminous field as observed at O appear of equal brilliancy. Owing to the uniformity of effect produced by the use of opal glass screens, the accuracy of focusing of this instrument is comparable to that of the best Bunsen photometer. The observation is completed by reading off the distance marked by the pointer upon the scale, *s*, and also recording the height of the candle flame, which should, if possible, be maintained at the length of two centimeters. It is evident that the principle of the instrument permits of the use of any other convenient standard of light as a substitute for the "*normalkerzen*" of paraffin or spermaceti.

Dr. Weber claims for his apparatus that it offers a convenient means of comparing with a standard the light of any flame, or other light source of small area in proportion to its intensity (*punktformig*). For this purpose the object-tube, B, is to be directed toward the light in question, which may be at any convenient distance, R, from the opal screen, *g*. For the required intensity I of such a flame we have the formula $I = C . \frac{R^2}{r^2} . c$; in which C is a constant, and *c* is the correction for the length of the candle flame when this does not correspond with the normal. Of course this correction may be otherwise expressed as a percentage of the result of the calculation, if preferred. The value of C has to be determined beforehand, as it is the allowance for the effect of the glasses of the apparatus, and must therefore be measured by reference to known standards. Thus, for determining C by measuring a standard candle, the tube B, is directed toward the candle, at a distance, R, of 50 centimeters. Then if *r* is observed to be = 30 centimeters, we have $C = \frac{30^2}{50^2} = 0{\cdot}36$. If the candle flame has to be corrected by 2 per cent., we have for the net value C = 0·353.

For the measurement of the illuminating power of a gas flame, with the same opal plates, the tube, B, being directed toward the flame and the results of observation being R = 1 meter, *r* = 20 centimeters, length of candle flame = 2·03. Then $I = 0{\cdot}353 . \frac{100^2}{20^2} . c = 8{\cdot}82$; which, with the necessary 3 per cent. correction for *c*, becomes 8·82 + 0·26 = 9·08 standard candles. Of course, for the measurement of very powerful lights, such as the electric arc, the distance, R, may be any required length to suit the limit of brilliancy available from the standard used.

For general optical purposes the apparatus may be used for the direct measurement of the brilliancy of self-luminous planes, in which case the opal glass is removed from the B tube. With suitable modifications, which it is quite unnecessary to describe in detail here, the arrangement serves for photometrical observation of the sun's disk. Another object which it serves very conveniently, but which is with difficulty obtained with ordinary photometers, is the measurement of the amount of light diffused in any space. For this purpose the degree of illumination of any defined spot is ascertained, and expressed in terms of the luminous surface. Upon this principle the amount of light actually received by any specified surface—such as a workshop bench, a table, a floor, or a roadway—may be measured and stated. For this purpose the standard of good and sufficient lighting may be fixed with reference to the service to be rendered, whether for reading and writing, handiwork, a *soiree*, or highway traffic. This is to be expressed as one, two, or more candle-feet—meaning the light of so many standard candles as received at a distance of 1 foot from the center of ignition. It is generally understood that the candle-foot is a reasonable and sufficient standard of diffused lighting for reading and working; and, with this as a datum, the value of any artificial illumination may be accurately compared by the use of such an arrangement as this of Dr. Weber's. It should be remarked that, although he writes only of the standard candle in connection with this photometer, Dr. Weber fully recognizes the limitations of such a standard, and ardently desires something more convenient and universally applicable.—*Journal of Gas Lighting.*

A CORD of seasoned wood weighs, say, 4,000 pounds. This cord of wood, placed in a charring receptacle and subjected to a proper temperature for, say, five days, entirely disappears. In its place we have 1,000 pounds of charcoal, 2,000 pounds of pyroligneous acid, and 1,000 pounds of uncondensed gases. The aggregate weight of these products is equal exactly to the original weight of the wood.

THE FAHNEHJELM WATER GAS INCANDESCENT LIGHT.*

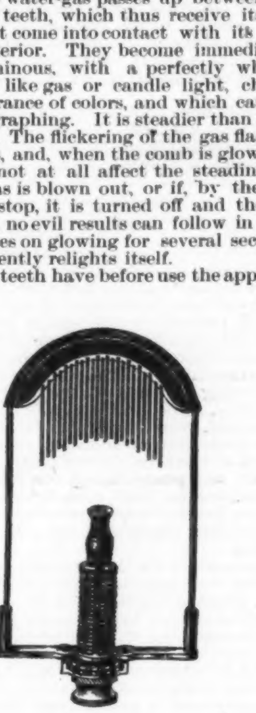
By R. W. RAYMOND, New York City.

THE idea of obtaining light from incandescent solids is not new; nor is it new to make such bodies incandescent by holding them in a heating flame. But the successful combination of the right substance and form of the body to be heated with the right kind of flame, and the right means of adjustment, has not, to my knowledge, been accomplished heretofore; and it seems to me that the water-gas incandescent light of Mr. Otto Fahnehjelm, of Sweden, in which these objects appear to have been secured, is destined to become both famous and useful.

The first fact upon which this invention is based is the intense temperature of the flame of water-gas. The combustion of this gas through an ordinary coal-gas burner, without blast or aid of any kind, will melt platinum wire.†

The next important basis of the invention is the form of the incandescent body. This is shown in the accompanying cut, which represents an ordinary fan-tail gas burner, fitted with the necessary apparatus for producing the new incandescent light. A frame, movable by means of a screw up and down along the burner, carries at its two extremities sockets to receive two iron wire standards, which carry a curved back, provided with two rows of long teeth. By turning the screw, these teeth can be brought as near the tip of the burner as may be desired. They are composed of magnesia, which has been first baked at a high temperature, then ground, and then moulded under high pressure, and with some agglutinating material, such as starch. The flat flame of the water-gas passes up between the two rows of vertical teeth, which thus receive its greatest heat, and do not come into contact with its comparatively cooler interior. They become immediately and beautifully luminous, with a perfectly white light, which does not, like gas or candle light, change the daylight appearance of colors, and which can even be used for photographing. It is steadier than the incandescent electric. The flickering of the gas flame (which is non-luminous, and, when the comb is glowing, quite invisible) does not at all affect the steadiness of the light. If the gas is blown out, or if, by the use of a cock without a stop, it is turned off and then unwittingly on again, no evil results can follow in this case; for the comb goes on glowing for several seconds, and the gas consequently relights itself.

The magnesia teeth have before use the appearance of



BURNER FOR WATER GAS INCANDESCENT LIGHT.

starch. When thoroughly well prepared, they should possess considerable strength. The best that have been made thus far, I believe, would sustain eight ounces avoirdupois hung from the middle of the needle which was laid across supports one inch apart. Since the diameter is less than $\frac{1}{16}$ of an inch, this indicates a good degree of strength. The needles are held in a composition of plaster of Paris, which fills the curved back of the comb. This back, like the side wires, is of iron; and the whole comb, with its side wires, costs about three cents.

Apart from accidental breakage, such a comb endures from 80 to 150 hours incandescence before it must be removed. The first effect of the high white heat upon the needles is to make them translucent, like porcelain. Probably this change is really a condensation, fusing into a continuous mass what had previously been but a compressed aggregate of particles. The result is a gradual shortening of the needles, so that after about 15 hours it is necessary to turn the screw, and bring the comb down toward the flame. This process is repeated from time to time, until at last the needles have become so short that the iron back would be in danger from the flame if they were brought fairly into it. Then the comb must be taken out, and a new long-toothed one substituted.

Exact photometric and economic tests have yet to be made *under American conditions*, and for water-gas produced by different processes. Speaking in a general way, I should say that the quantity of pure water gas required to produce a given amount of light by this system is about four-fifths (in volume) the quantity of *carbureted* water-gas, like the Tessie gas of the Municipal Company of New York, required to give the same amount of light. The cost of the non carbureted water-gas is, of course, much smaller. It can be sold to large profit for 50 cents per thousand cubic feet.

We have then in this invention, a light which is actually much cheaper than ordinary gas light, while in quality it equals, and in steadiness, uniformity, and simplicity of management far surpasses, the electric incandescent light.

* Read at the New York Meeting of the American Institute of Mining Engineers, February, 1885.

† Mr. Otto Fahnehjelm, the inventor, who was present at the reading of this paper, demonstrated the truth of this statement experimentally before the audience.

ON THE REAL VALUE OF LUBRICANTS, AND ON THE CORRECT METHOD OF COMPARING PRICES.*

By ROBERT H. THURSTON, M. Am. Soc. C. E.

THE real value of any lubricant is a quantity which seldom has any direct relation to its market price, and depends not only upon the intrinsic qualities of the unguent itself, but upon the economical conditions under which it is to be used. It is dependent to a greater extent upon the magnitude and cost of power than upon the expense of its purchase or preparation for use by the consumer. The correct method of comparing prices, from the user's standpoint, is not one involving merely a determination of the properties of the material as a reducer of friction, and the true value of the oil is not simply proportional to its endurance and its power of reducing lost work; it includes a study of the method by which it reduces the total expenses of lessening the friction, and the extent to which the total expense for power is reduced by such reduction of work wasted by friction. The usual systems of comparison are entirely wrong, and are only justifiable by the fact that hitherto it has been impracticable to obtain the data required for the establishment of a correct method. This difficulty no longer exists, and every intelligent purchaser of lubricants is coming to see that he may often effect enormous economies by the careful study of the variation of the total cost of lubricant and of waste power.

The total cost of the lost work in machinery includes two distinct items—the cost of lubricant and the cost of doing the work of overcoming friction of the lubricated surfaces. Of these, the latter is usually enormously the greater, and it is at once seen that a saving in cost of lubricant is of slight importance in comparison with a saving of equal proportion in the reduction of the cost of the power demanded to overcome friction, and which is thus wasted. A dollar expended in the substitution of good oil for one of lower grade may save a hundred by reduction of the waste of fuel and other expenses of power-production. Such expenses include fuel, salaries, interest on capital invested in motive power, taxes, and insurance on the driving machinery, boilers, and building, and other minor costs, which every proprietor can readily estimate with fairly accurate figures, if not with perfect satisfaction to himself. The total cost of steam power thus foots up to about $100 per horse power per annum in New York city, and to a minimum of, perhaps, $50 under more favorable conditions. Water power often costs considerably less, although the cost of dams, reservoirs, and machinery is large.

If, in any case, we call the total expense per hour K, the cost of the lubricant on the journal k, the quantity used q, the total cost of power per horse power per hour k', and the amount of power used in overcoming friction of lubricated surfaces U, the total expense chargeable to "lost work" will be

$$K = k\,q + k'\,U \tag{1.}$$

The work done in overcoming friction U is proportional to the mean pressure on the lubricated surfaces P, to the speed of relative motion of rubbing surfaces V, to the time taken for comparison t, and to the magnitude of the coefficient of friction f. Thus we may write

$$K = k\,q + b\,f \tag{2.}$$

in which b is a constant, the value of which, $k'\,P\,V\,t$, is easily ascertained in any given case, and the calculation of the cost of friction is then readily made.

Where two oils are to be compared, to determine the economy to be secured by the substitution of the one for the other, the values of q and of f, and the cost per gallon, k, of each will be known, and the two values of K thus obtained will exhibit the relative economy of their use. If K is the same for the two, it is a matter of indifference which is used; if K is greater in one case than in the other, that oil is the more economical which gives the lower value, even though it may cost more per gallon, and may require to be more freely used than the other. Thus, suppose, for the two cases we have

$$K_1 = k_1\,q_1 + b\,f_1;\quad K_2 = k_2\,q_2 + b\,f_2$$

If these two values of K were equal, $K_1 = K_2$, and the gain by purchasing the second oil is just compensated by the loss due to increased demand for power to overcome the increased friction, and

$$k_1\,q_1 - k_2\,q_2 = b\,(f_2 - f_1) \tag{3.}$$

$$k_2 = \frac{k_1\,q_1 + b\,(f_1 - f_2)}{q_2} \tag{4.}$$

Any price paid for the second oil, *delivered on the journal*, less than k_2 gives a profit; any greater price produces loss. This last equation is thus a criterion by which to determine what price, k_2, may be paid for any oil proposed to be substituted for the first oil, costing $k_1\,q_1$ per hour.

Where the same quantity is used of each, as may be the case frequently, $q_2 = q_1$, and

$$k_2 = \frac{b}{q_1}\,(f_1 - f_2) + k_1 \tag{5.}$$

The question sometimes arises whether it is better to use a larger quantity of a certain oil already in use; in this case, $k_2 = k_1$, and the quantity allowable without loss is

$$q_2 = \frac{b}{k_1}\,(f_1 - f_2) + q_1 \tag{6.}$$

Where the relative endurance, and the relative values of the coefficient of friction, are determined by experiments made under the conditions of proposed use, if e and h represent the two ratios, since the quantity used will be inversely as the endurance, and the power wasted will be directly as the coefficients of friction,

$$k_2 = e\,k_1 + b\,e\,f_1\,\frac{1-h}{q_1} \tag{7.}$$

and this expression becomes the criterion of values.

Instead of taking the time as one hour and the unit of the power as the horse power, it may be convenient to adopt other units. Thus on railroads the costs are measured by the cost of oil and of power per train mile, and

$$K = k\,q + d\,f \tag{8.}$$

in which q is the quantity of oil used per mile, and $d\,f$ is the cost of power for the same distance. Also, as a criterion,

$$k_1\,q_1 - k_2\,q_2 = d\,(f_2 - f_1);\; k_2 = \frac{k_1\,q_1 + d\,(f_1 - f_2)}{q_2} \tag{9.}$$

In illustration of the application of these principles, take the following cases:

(1.) The proprietor of a large machine shop informs me that he finds the total expense of power to be nearly $100 per horse power per annum, of which power one-half is estimated to be expended in doing work wasted in friction; that he uses 0·02 gallon per hour of good lubricants, costing an average of $0.50 per gallon. The mean coefficient of friction is judged to be about 0·05. The value of b (eq. 2) is found to be 0·6 horse power, or 30 for 50 horse power; then

$$K_1 = 0.01 + 1.50 = \$1.51.$$

Suppose it be proposed to substitute for the oil in use one which costs but $0.25 per gallon, and of which 0·03 is required per hour, and that the coefficient of friction with the cheaper oil is $f_2 = 0·6$; then

$$K_2 = 0·0075 + 1.80 = \$1·80\tfrac{3}{4},$$

and a gain of one-quarter of a cent per hour, or $7.50 per year, is effected at the expense of a loss in cost of power of 30 cents an hour, or $900 a year, and a net loss of $892.50.

(2.) A cotton mill, using 200 horse power, in work of overcoming friction of lubricated surfaces, uses 0·7 gallon of oil per hour, at $0.70 per gallon; it is proposed to substitute an oil costing $0.40, and of which one gallon per hour will be required to do the work, while the coefficient of friction will rise from an average of 0·10 to 0·12. Taking b at 60, as before:

$$K_1 = 0·49 + 12·00 = \$12.49;$$
$$K_2 = 0·40 + 14·40 = \$14.80.$$

A gain in expense for oil amounting to 9 cents per hour, or $270 per year, produces a loss in cost of power of $2.40 per hour, or $7,200 per year, assuming 3,000 working hours per annum. The net loss is $6,930, *i. e.*, nearly 30 times the profit on the oil account. This is not an unusual or an extraordinary case, as matters are now going on in the business.

(3.) A railroad train requires one cent's worth of oil per mile, and costs 10 cents per mile for power expended in friction, using a good oil, costing 50 cents per gallon, at the rate of 0·02 gallon per mile, with a mean coefficient of friction of 1 per cent. It is proposed to change, using an oil costing but 25 cents, at the rate of 0·03 gallon per mile, and obtaining a co-efficient of $f = 0·015$; then

$$d\,f_1 = 0·10;\; d = 10 \text{ (eq. 8)};$$
$$K_1 = 0·1 + 0·10 = \$0.11;$$
$$K_2 = 0·00.5 + 0·15 = \$0.15.$$

In this case, a gain of one-quarter of a cent per train mile in cost of oil brings about a loss of 4 cents—sixteen times as much—in increased train resistance.

Using the quotations given as criteria of values (eq 4, 6, 9), we find the estimated value of k_2 to be, in the three cases given, respectively: —$19, —$2, and + 16⅔ cents, nearly, for the cases as taken. That is to say, the proprietor of the machine shop will lose $19, nearly, on every gallon of the proposed oil that he may use; the owners of the cotton-mill will lose about $2 on every gallon of inferior oil that they may purchase; while the railroad will lose money, unless it can get the second oil for 16⅔ cents.

But suppose, in further illustration, it is found possible, by increasing the supply of oil in the case of the machine shop, to reduce the mean coefficient of friction to 0·02, by using four times as much of the cheaper oil as was at first thought advisable. Applying our criterion to the case, we get (eq. 4):

$$k_2 = 0.03 + 0.60 = \$0.63;$$

and a gain is effected of nearly two-thirds the original cost of lubrication. An expenditure of $60 gives a profit of about fifty times that amount.

It must not be assumed that these figures are more than rough approximations to fact; for it is difficult to obtain exact values of the quantities involved, and especially of the true mean value of f; but they are sufficiently correct to answer as illustrations of the principles involved, and are near enough to the truth to give a fair idea of the magnitude of the losses which are each day met in consequence of the practice of the system of false economy now generally practiced in the purchase of lubricants.

The values assumed for the coefficients of friction are probably fairly representative of those found in common practice. The experiments made by the writer show that, under ordinary conditions of every day practice, the value for mechanism working under as light pressures as are met with in spinning frames, for example, different oils will give values varying from 1·10 to 0·25; under the usual pressures of heavy mill shafting, the figures range from 0·5 to 0·16; with pressures of greater intensity, such as are met in the steam engine and under railroad axle bearings, it often varies, using different lubricants, from about 0 01 up to 0·025, the first value being given by the best oils and the second by heavy greases. Under the exceptionally high pressures and at the speed of rubbing reached on the crank pins of some steam engines (500 to 1,000 pounds per square inch; 35 to 70 kgs. per sq. cm.), f may fall to one-half the last given values. In endurance, the same variations are met with. The endurance decreases as pressures increase, and is twice as great with the best oils as with others of good reputation. The market prices of oils have no relation to these relations of quality. The best oils for any given purpose may be either more costly or cheaper than others less well fitted for the work. In some cases prices are made in the most arbitrary manner.* Sperm, lard, olive, and some few standard grades of mineral oils probably have fair and well settled values; as a rule, however,

* Read before the American Society of Civil Engineers, Jan. 7, 1885.

* The writer has been informed of one case in which the dealer purchased an oil for 12¼ cents per gallon, gave it a trade name, and sold it, unchanged, at $1.25. It was worth that amount, however, if compared with other oils in the market that may have cost the "maker" much more.

the price of a mineral or of a mixed oil is no guide to selection

Should time permit and statistics prove to be attainable, the writer will endeavor to develop this subject more completely.

THE PROCESS OF BRONZE CASTING AS APPLIED TO SCULPTURE.

THE *cire perdu* process of bronze casting was the subject of a recent Royal Academy lecture by Mr. E. J. Boehm, R.A. The practical working of this process of casting the matrix from a wax model which is melted out was illustrated by the exhibit of a bronze bust still surrounded by the runners, air vents, and gutters, and also of the plaster of Paris matrix in which it was cast.

In his introductory observations Mr. Boehm gave a brief historical sketch of the process of bronze casting, in order to show that the *cire perdu* process was the oldest mode of the art. Long disused, it now bid fair to supersede the present imperfect way of making art castings, if sculptors and founders would take the trouble to carry it out.

A process analogous to *le cire perdu* was practiced even in prehistoric times, the old bronze weapons appear to have been carved in soft wood, which was covered with clay and fired.

A similar method of casting natural subjects protected by a fireproof casing was practiced by the Egyptians, the Japanese, and the modern Neapolitans. In early examples of the Egyptian, Greek, Etruscan, and some Roman works were found parts of a core of terra cotta still remaining in the bronze objects, showing that a similar process was adopted, and there was no doubt that the fifteen hundred bronze statues said to have been executed by Lysippos were by the same process.

Cellini, in his delightful autobiography, tells us that he adopted the same process for casting the Perseus at Florence, but the means now adopted were simpler and safer than that he devised.

Mr. Boehm proceeded to describe the present method, as follows:

The model in clay being finished and reproduced in plaster of Paris, a mould is made over the reproduction, technically called a piece mould, out of which a cast is made in wax, quite hollow, and about the thickness of ⅛ inch. This having been done, and the seams on the surface of this wax caused by the juncture of the pieces of the mould being taken off, and all requisite and necessary retouching and corrections being made, the founder commences to fix on the runners, vents, and gutters, preparatory to making the fireproof mould over the object; and for this purpose he has prepared a number of sticks of wax, similar to that used for the cast. A great deal of skill is required for this operation, and the success of the cast depends greatly on the manner in which these sticks of wax are put on; which eventually are to become hollow, and act as channels for the escape of the wax from the mould during the firing, for conveying the molten metal throughout the mould, and for the air vents through which the air and gases are to escape, driven before the molten metal during the casting. One of the larger of these sticks of wax of which I have just spoken is selected, and the moulder having decided as to the best part of the wax model for attaching the main channel to, slightly heats the end of the stick of wax and applies it to the part, making it fast by passing a small iron or steel modeling tool, which he has heated for the purpose, round the juncture in order to thoroughly secure the joint. (This is the piece which starts out of the center of the back of the head of bust.)

The operation is repeated in precisely the same manner with regard to the other four large conduits, which are all joined carefully to the extremity of the first one. He then adds the smaller ones, taking care that they shall all take a downward direction, so that no stoppage in the flow of the metal shall take place during the casting.

These conduits placed, the moulder is able to judge of the best points at which to fix the air vents; and he takes care to arrange them in such a manner that they shall not come in contact with the runners just finished, but that they shall readily conduct the air which is driven from the mould by the metal which takes its place as it escapes. The drains are now placed, and the same care is taken in their placing as has been observed with regard to the other tubes; and that they shall thoroughly fulfill their function, they must be quite straight toward the direction of their exit, and be free from all complication. A round funnel is now made, either in wax or paper dipped in melted wax, which is attached to the runners at their junction.

The next operation is to prepare for the "core." In order to provide for the escape of the gases which are generated in the core, which is of a porous nature, during the firing of the mould, to destroy the wax, two smooth iron tubes, well greased, are inserted into the wax, so that one end of each penetrates into the middle of the hollow in the wax model, and the longer end stands out on a level with the top of the runners where the funnel joins.

In Italy an automatic process is frequently employed for making the core of small objects simultaneously with the mould for works of the size of the model before us; and to give you an idea of the principle of it, I have prepared this small model in glass, the working of which I will show you at its proper time; but first of all I must proceed with a short description of the further preparation of the model for the mould and "core."

Iron nails, like those on the table, are slightly heated, and thrust through the wax until the one-half only projects on the outside of the cast and the pointed end penetrates into the inside. The heat of the nail so inserted slightly melts the wax all around it, which when set holds it firmly in its place. These nails having been placed in the parts least susceptible to damage, and the easiest repaired should any occur, the whole model is immersed in a tank of cold water, through which there is a constant flow of fresh water; the object of this being to insure against the settlement of any sediment from the water on any part of the wax, which might cause injury to the mould in firing. The model is left thus for a few hours, and when the wax is thoroughly hard and brittle it is carefully taken out, and is placed on a table or bench at a convenient height from the ground. While the water which still remains on the surface and in the hollows of the wax drains off, or is removed by an assistant with a small brush or sponge, the moulder prepares his composition for making the mould; this is composed of plaster of Paris and brickdust mixed with water, in precisely the same manner in which plaster of Paris is mixed for moulding objects from clay. By this time the model is ready to receive the mould, and the moulder, with the assistance of help he can trust, commences to lay on the composition with a fine and soft brush, taking care to well fill all the crevices and hollows. In this manner a thin coating having been laid all over the surface of the wax, the whole, as it stands, is lifted three or four inches from the table on which it stands, and at such places as may be deemed necessary pieces of brick are placed under it, upon which it may rest raised from the table. The next thing to be done is to build a wall all round the object, at such a distance from it as the moulder will decide. This wall is smeared all over with clay, in order to render it entirely water-tight. A fresh mixing of the composition is made, but this time some that has been used before and has been thoroughly well burnt is well ground and added. This new mixing is poured gently into the space between the wall which surrounds the mould and the mould itself, and as the liquid composition rises it will penetrate throughout the interior of the wax within the mould, simultaneously with the outside setting as it rises round the points of the nails and finding its exit with its level on the outside through the hollow tubes, which you will remember were inserted for the purpose of forming gas escapes from the "core." It is very important that the "core" should be composed of exactly the same proportions as the outside mould, and it is here where the automatic system of forming it is so valuable.

Firing is the next process, to expel the wax from the mould. The block is placed upon a brickwork stage about two feet from the floor, and round it a furnace of firebricks is constructed, two chimneys being placed on the runners, and the escape vents communicating with the outer air. Round this furnace a second one is built, which is filled up with charcoal and coke. The fire is then lighted, and allowed to burn gradually at first, and increased slowly until the block within is thoroughly baked throughout, so that it has been completely heated to its very center. After a few hours, the wax flows and escapes through the drains, which were connected with the outer air by iron tubes passing through the furnaces, at the same time that the chimneys were placed over the "runners" and air vents at the time of building the first furnace. These outlets communicate with receptacles into which the wax flows. When the flow of wax ceases, care is taken to close the openings of these tubes, to prevent the entrance of the air into the interior of the mould, which would probably ruin the whole work. The fire is kept steadily burning, and the founder watches the chimneys which protrude through the top of the furnace, and which I have already said were attached to the head of the runners and air vents. After several hours' firing, puffs of blue smoke are seen to issue from the chimneys, which is a sign that the heat has been sufficient to evaporate any wax which may have been absorbed by the mould after its main bulk had run out through the drains. Still a few more hours, and the smoke becomes of a reddish color, and is succeeded by a vapor. The wax is now entirely destroyed. The fire is still increased to insure disappearance of all moisture from the mould, and from time to time the founder applies a cold polished steel plate or a piece of ordinary looking-glass to the orifice of the chimneys, through which he is able to detect the slightest indication of moisture still remaining. Being satisfied that the mould is thoroughly free from all moisture, the fire is covered up and allowed to burn itself out gradually. As soon as the fire is extinguished, the outer wall of the furnace is thrown down, and a few of the bricks of the inner wall are also removed to hasten the cooling of the block within. By degrees the whole of this wall is removed and the block is allowed to cool slowly, for sudden changes of temperature would, in all probability, cause the mould to crack, and the whole work would be defective.

I made reference to the use of iron nails being pressed through the wax. Until the block was submitted to the action of the fire, it was a solid mass; but now, since the wax has disappeared, the "core" has become isolated, and now is only kept in its place by the points of the nails, round which, during its formation, it has set, and they in their turn are kept stationary by the outside mould, which set round the portion which projected on the outside of the wax at the same time.

When the block was placed ready for firing, it presented a comparatively hard surface; but now it has undergone the great heat of the firing it has become extremely pliable, and is easily damaged. Directly the mould is sufficiently cool, it is carefully bound with iron hooping, and lowered into a pit which has been dug to receive it; and ordinary sand or moulding earth is pressed with the greatest care all round it until it is entirely buried, and only the mouth of the conduits and the air vents are visible. This precaution is necessary to avoid accidents occurring from the expansion of air, and the pressure of gas caused by the flowing of the fused metal through the mould.

Round the opening of the vents and air channels a basin-shaped hollow is scooped out in the block; the funnel of the runners is closed to prevent the current of air through the mould until the metal is ready to be poured. All is now ready for casting. In order to calculate the amount of metal required for casting a group, the wax model, prepared as it was with its tubes, which were solid in wax, but which have now become hollow in the mould, was weighed, and according to its weight a certain percentage on the whole over and above the weight is added, to allow for the difference in the specific gravity existing between wax and bronze; and for the runners, vents, and drains, which all become bronze by the flowing of the metal through the mould, and its surplus returning to its level through the vents.

The metal is poured gently into the mould, the stopper from the funnel over the runners having been removed; and now is the anxious moment for the founder, who listens attentively for the slightest noise in the mould, which is a sure sign of non-success. The metal soon solidifies, and in a very short time is cool enough to allow of the block being broken up. This is easily done; for by this time it has become so soft that it can almost be removed with the fingers. An unpracticed eye, even when the mould is entirely removed, can hardly detect whether or not the cast is really successful, encumbered as it is by the network of solid rods of bronze, which were formerly the tubes for conveying the metal into the mould, and the air, wax, and gas from it; and, in addition, there is a white crust left from the surface of the mould still adhering to the object itself.

The runners, vents, and drains are sawn off, the nails withdrawn, the core picked out, and the object is placed in a bath of water and sulphuric acid for several hours, and when it is taken out, it is vigorously scrubbed with hard brushes, rinsed in clean water, and allowed to dry. The holes left by the nails are stopped, and all traces of the joints of the vents and runners are effaced, and the cast is then ready to receive its patina, or artificial coloring in imitation of that produced by oxidation.

As the patina of a bronze is quite a question of taste, and is obtainable by an endless variety of means, according to the effects required, I prefer to dismiss the subject, and I am obliged to refrain from entering into the very elaborate subject of alloys of copper for bronze, and their melting and blending together, rather than enter upon them in too slight a manner, and time would not permit of my doing otherwise to-night.

In conclusion, I need not point out the great advantages which the *cire perdu* process has over bronze castings from moulds made in sand, and I am sorry to say sometimes in woolly loam on plaster models; which system requires the removal of not only the seams left by the joints of the piece mould, but more or less of the entire surface, in order to produce an even texture throughout. Could and would the sculptor do that himself, and give with the chasing tool that character so peculiarly beautiful in the metal work of the Greeks, and many bronzes of the Renaissance, then any method of reproducing would be acceptable and justifiable; but this is scarcely ever achieved. And in the hands of the usual metal chaser the result is generally disastrous.

We can only hope that the art of bronze casting will eventually meet with the encouragement and result which will elevate it from the commercial iron foundry to an art, and not a brainless trade only.

[AMERICAN ARCHITECT.]

HINTS ON PLASTERING, MORTARS, ETC.

IT is not an uncommon complaint from proprietors of dwellings, hotels, office buildings, etc., heated by furnaces or by steam, that in a few years after being constructed the interior finish of brick walls commences to scale off, if painted, or the entire plastering comes loose from the walls in patches four or five yards in extent, and seemingly rotten, the cementing qualities all gone. This scaling off of the paint or falling off of the plastering being confined to the brick walls only, the stud partitions, lathed ceilings, and furred brick walls remaining good, there is no room for doubt but that a very large proportion of the mortars used in the construction of modern brick walls, as well as that employed for plastering, is improperly proportioned, badly mixed, and too quickly used, and hence possesses only in a low degree those valuable properties of strong coherency of their component parts and the quality of adhesiveness.

The responsibility for the damages to buildings arising from the employment of poor qualities of mortar should often rest as heavily upon the architect as upon the contractor, the bricklayer, or the plasterer. In the vast area covered by the United States, there are so many different kinds of mortar employed for the purposes of constructing and finishing buildings, that it would be impossible to formulate a rule which would result in producing a good mortar from the materials found in the various sections of the country. But it is the business of the architect to thoroughly familiarize himself with the materials found in the section covered by his practice and used for mortar making. After becoming acquainted with the materials, the architect should specify the qualities and proportions of lime and sand to be employed, and the manner of mixing, and the age of the mortar before use.

As the defects which have been mentioned are confined to the interior finish of brick walls, and do not affect ceilings or other plastering work not in actual contact with brickwork, it is evident that we must look farther than the plastering for the cause of the damage. Experience has clearly demonstrated that mortar, of whatever kind, is greatly affected, either for good or for evil, by the nature and the quality of the bricks or stones with which it is brought in contact, and, consequently, in order to obtain the best constructive results the material over which the mortar is applied should receive proper attention. An experiment made by the writer, with a view to demonstrating the action of the ordinary mixture of cement and lime mortar used by bricklayers in the city of Washington in foundation work on the common varieties of bricks, showed that the strength of the same mortar greatly varied with different kinds of bricks, being lowest with those of greatest porosity. Two hard-burned arch bricks, each having a surface measurement on their mortar faces of 7·75x3·75 inches, separated under a pull of 43 pounds to the square inch. Two red bricks measuring 3·25x4·06 inches separated under a pull of 34 pounds to the square inch. Two salmon (soft) bricks measuring 8·75x4·3 inches separated under a pull of 15 pounds to the square inch. The bricks had lain together for about six weeks, and the joints of mortar between them were one-half inch thick, the same as those used for ordinary brickwork. The bricks were good hand-made stock, moulded from moderately strong clay, but if they had been manufactured from meager or weak clay, the results would have been lower than those which have been given. The cementing qualities of mortar, consequently, not only depend upon the kind of bricks to which it is applied, but also upon the nature of the clay from which the bricks are made, and also upon the manner in which they are moulded. Bricks made from tempered clay and solidly moulded increase the cementing qualities of mortar, but bricks made by the so-called dry-clay machine process lessen the strength of the mortar, as the first class of bricks are close and compact, and the latter are commonly open and porous. The poor results obtained with "salmon" or soft bricks were unquestionably on account of their great porosity, as during the setting of

the bricks the mortar yielded its water of hydration too quickly, the porous bricks soaking it up more ravenously than would be done by a sponge. This is not to be wondered at, when we remember that each "salmon," or soft brick, can easily absorb one and one-half pints of water.

From the foregoing remarks it will be seen that the falling off of the plastering from brick walls is more liable to happen in structures, the interiors of which are built with "salmon" or soft bricks. Some plasterers take the precaution to thoroughly wet the walls constructed with salmon bricks before applying the plastering. But even a thorough drenching of the bricks is of much less value than is commonly supposed, and can never be depended upon to secure immunity from damage in all cases. One reason why dampening the salmon-brick walls with water is not effective is that the plastering is commonly put on the walls during the summer season, and during exceptionally warm weather the evaporation of the water quickly takes place, and the porous bricks continue to absorb the moisture from the mortar, thus robbing it of its strength.

In cheap and shoddy buildings erected for speculative purposes, it is not a common custom among architects, proprietors, or contractors to bestow much thought upon the manner in which the plastering or any of the other branches of construction is performed; but in all other cases it is better, if salmon bricks have to be used, for the architect to specify that all walls constructed of soft bricks shall be furred.

In the November and December, 1884, monthly numbers of this journal, the writer treated the subject of "Saltpeter Exudation upon Brickwork;" and if the plastered or painted walls should be damp, the interior finish would be destroyed in the same manner as brick walls exteriorily finished by painting or with stucco, as was explained in the previously mentioned article, and which explanation it is probably not necessary to recapitulate in the present paper. In case the plastering is liable to become detached from brick walls on account of dampness, furring is the only remedy.

Having recommended furring, for dry walls constructed of soft bricks, as well as for damp brick walls, it now only remains to say in the same connection that those portions of structures which are to be continuously inhabited, such as sitting-rooms, chambers, etc., of dwellings, ought never to be plastered directly upon the brick walls. In buildings which are designed to be fire-proof, iron lathing would, of course, be employed in lieu of furring.

In our large cities, cast iron for architectural purposes continues to be commonly used for the piers or columns of the lower floors of stores and warehouses. These piers are sometimes hollow iron columns, ornamented on the sides and exposed to the weather, in order to produce the desired architectural effect, and plain on the side or sides which form part of the walls of the apartment which the piers aid in inclosing. These apartments or stores are usually plastered, or have what are commonly termed hard-finished walls, and it is desirable that the inner sides of the piers should correspond in finish with the other parts of the interior walls. The inner sides of the iron piers are, therefore, often partially cased with furring to which laths are nailed in order that the surface may be plastered; in other cases, the iron surface is wholly covered with a wainscoting or casing of boards, and at other times the iron surface is merely painted. Both the furring and the wainscoting are objectionable on account of the expense and their tendency during a conflagration to warp and often break the columns, and when merely painted the surface is not good. A method which is now common property has been successfully used to obviate the defects which have been mentioned, and it consists in piercing that surface of the pattern which corresponds with the inner surface of the pier to be plastered, with a number of small holes in which are loosely inserted either wrought or cut nails, or small pieces of wire, or cones or pyramids of cast iron, so that they shall project from the surface. When nails are used, they should be put in point first; when wire is employed, the axis of the wire should form an oblique angle with the surface, and all the nails or cast iron should project from the surface of the pattern, as far as may be necessary to insure a lock for the plaster. When the pattern is prepared, it should be laid face upward in the flask and moulded upon in any proper way, and when the pattern is drawn, the nails, wires, or pieces of cast iron are to be left sticking in the sand; when the iron is poured in, it will surround the nails, etc., and when cold and removed from the sand the surface of the iron pier or column will be of such irregularity as to retain the plastering. Surfaces produced in this manner can be readily plastered after the piers or columns are placed in position, and the finish obtained upon them is better than that produced by furring the columns or piers, and in addition it is cheaper, more durable, as well as more economical of space, and protects instead of endangering the piers or columns in case of fire.

Casing iron piers and columns with fire-proof materials, as well as lathing with iron lathing, is now often practiced, in the construction of expensive buildings, but the method previously described could often be used to great advantage in cheaper structures where first cost is an item.

Having in the foregoing portions of the present paper somewhat enlarged upon the preparation of good foundations for the reception of the plastering, the questions might reasonably be asked: "Do not the defects mentioned in the commencement of this article often occur from the employment of inferior mortar? and, What constitutes good mortar, and what is the theory of its preparation?

To the first interrogatory we would unhesitatingly reply in the affirmative. Too much and poor quality of sand, too little and poor quality of lime, too little mixing, too little time for aging, too little time for drying after applying the mortar to the wall, too much hurry to get on the white coat, and get the cash for the job, are defects which are only too apparent under the present system of contract work to be enlarged upon here. There is no possible way to remedy these defects except through architects and superintendents charged with the execution of the work, for just so long as such defective plastering is accepted and passed by those whose duty it is to condemn it, just so long will the evil continue. There is, of course, no excuse for an architect or any other person who would abuse his power to such an extent as to impose unnecessary expense and trouble upon a contractor. But duty to his client and his own interest demand that an architect shall specify the proportions and qualities of the ingredients employed for mortar, and require and know when it has been properly prepared and applied.

The second interrogatory, "What constitutes good mortar, and what is the theory of its preparation?" is not readily answered, especially the first clause of the question. "Mortar, being a compound concocted of such variable ingredients, and subject to a great variety of treatment, no specific value or estimation is possible, unless it is described as being compounded of a certain quantity of lime, to be mixed with a definite quantity of sand." We have previously stated in substance that "the best and most desirable property in a good mortar is, that the materials of which it is composed shall not only be competent to secure profitable coherency of its component parts, but also possess the quality of adhesiveness, and thus bind together or cling to the bricks or other forms in the structure in which it is to be used."

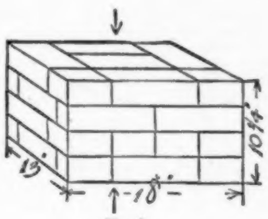


Fig. 1.

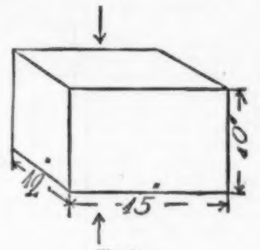


Fig. 2.

Aiken states the general theory of mortar as follows: In the white limes or nearly pure carbonates of lime the only effect of burning them is to drive off the carbonic acid. By slaking the lime becomes a hydrate, and in this state is capable of acting chemically, though feebly, on the surface of pure silicious sand. This combination causes the first setting of the mortar, which is also strengthened by the mere mechanical action of the sand. The greater part, however, of the lime has not combined with the sand, but remains in the state of a hydrate. In proportion as this latter absorbs the carbonic acid from the air, it gives out its water and passes to the state of carbonate; such mortar, therefore, acquires its final induration and dryness when the whole of the hydrate has been decomposed and the water has been replaced by carbonic acid. In losing twenty-two per cent. of water it combines with forty-six per cent. of carbonic acid, and, therefore, the mortar becomes the more solid and strong.

Limes derived from comparatively pure carbonates have a decided tendency either to yield their water of hydration too quickly, or not to part with it at all. If the water of hydration is permanently retained by the lime, there results a moist, pasty product, and if yielded too readily, the rapid loss of the water of hydration results in a dusty, pulverized mass.

The Romans in dealing with such limes invented numerous shifts to counteract the tendency to the extremes which have been mentioned. "Hence, we find in the best remains of the old Roman mortars a careful and perfect blending of the lime with the sand, and generally the insertion of thin porous tiles or bricks to absorb any superfluity of moisture." The Romans were the best mortar-makers of history, and it was an absolute condition imposed upon all persons engaged in engineering as well as architectural construction, that the ingredients of which the mortar was composed should be thoroughly blended together.

The differences between fat, poor, and hydraulic limes are so commonly understood that it is not necessary to enlarge upon them here. But whatever may be the character of the lime, if it has been freshly burned and the details of its manufacture have received proper care, it should be capable of thorough incorporation with any suitable material for the production of mortar.

It is, of course, evident that there should be used sand which is as clean, sharp, and as coarse as possible. Should the sand not be naturally clean, it is essential that it should be freed from foul and loamy admixtures by washing. For the production of good mortar it is an imperative condition that each particle of sand shall be completely coated with lime; fine sand, consequently, requires a larger proportion and a more diffusive state of the hydrate of lime than a sand coarser in its nature. Bank or pit sands, on account of their mixture with fine silt or loam, are not usually so desirable for mortar-making as those taken from rivers and similar sources. Sea sands, unless thoroughly washed, retard the setting and destroy the strength of mortars.

When a "batch" or quantity of mortar is to be "made up," all of the lime necessary should be slaked at least twenty-four hours before it is used. On slaking the lime all the water required should be "run on" at about one time, and after the lime has been properly submerged, the mass should be covered with a layer of sand or otherwise, and allowed to remain undisturbed for the required period. The common error of working the lime with the hoe during the time it is slaking should not be practiced. As all mortars are greatly improved by working them, "and as fat limes gain somewhat by exposure to the air, it is advisable to work mortar in large quantities and afterward render it fit for use by a second manipulation." The foregoing remarks apply to bricklayer's mortar as well as to coarse stuff used by plasterers for first and second coats; but in regard to the hair used for the latter classes of mortar, it may not be amiss to state that it should be only medium in length, properly cleansed from the lime or other substances used in depilating the hides, free from lumps, and dry. Various materials, such as sulphates, etc., have been employed for increasing the strength of lime mortars, and when plaster of Paris is used for such a purpose it should be added in small quantities and thoroughly mixed with the lime, and in case of such addition of a sulphate, the proportion of sand can be somewhat increased.

On account of the interest usually exhibited regarding the strength of brickwork when laid in either lime or cement mortar, and also of concrete when composed of cement mortar and broken stones or other similar material, we here append a description of two mechanical tests by compression made with such materials at the Watertown Arsenal, Mass., on the 18th of November, 1884.

These tests were made at the request of General Montgomery C. Meigs, U. S. Army, who communicated them to the writer.

The specimens were taken from the foundation under the steps leading to the north portico of the Capitol building, at Washington, D. C., the steps having been lately removed in order to allow the construction of the marble terrace wall now in progress around three sides of the Capitol building. The bricks and concrete were laid in position under the direction of General M. C. Meigs, twenty-five years previous to the time when the tests took place, the results of the tests being as follows:

Bed surfaces faced with plaster of Paris.

Figure 1. Four courses of brick laid in cement mortar.
Average thickness of bed joints, $\frac{5}{8}$ inch.
Total weight, 178·5 lb.
Weight per cubic foot, 128·6 lb.
Compressed area, 13 x 18 inches = 234 sq. inches.
First crack at 360,000 lb. = 1,538 lb. per sq. inch.
Crushing strength, 578,000 lb. = 2,470 lb. per sq. inch.

Figure 2. Concrete composed of cement mortar and broken stones.
Irregular block.
Total weight, 150·5 lb.
Weight per cubic foot, 144·5 lb.
Compressed area, 12 x 15 inches = 180 sq. inches.
First crack at 112,000 lb. = 622 lb. per sq. inch.
Crushing strength, 135,300 lb. = 752 lb. per sq. inch.

CHARLES T. DAVIS.

FOUDROYANT CHOLERA.

DR. JAMES CHRISTIE, of Zanzibar, has given the most graphic account of this in his admirable book on the "Cholera Epidemics of East Africa." He says: "A near neighbor of mine sent for me about midnight to see a remarkably handsome Galla woman about twenty years of age. There had been several cases of severe cholera in the house, and I was sent for at once, and saw her within a quarter of an hour after she first felt any symptom of illness. She seemed in perfect health, except that she had been suddenly seized with vertigo and a sensation so peculiar that she was certain that she was going to die. There had been no nausea, vomiting, diarrhœa, or cramps. I examined her most carefully; there was no pain or tenderness, no coldness, nor any depression of temperature. There was only a certain wildness of the eyes, a restlessness of manner, and an anxious expression. There was no failure of strength; she could walk as well as ever, but she was pulseless at the wrist, although I imagined I detected a threadlike quivering of the radial artery now and then. The heart's action seemed unusually strong and rapid, as if the greatest cardiac power was exerted to propel the blood to the remote capillaries; but in less than a quarter of an hour she was absolutely pulseless at both wrists. I imagined the case was not hopeless, and tried to reassure and comfort her; but turning to her master, she said, 'Oh, my master!' and threw herself upon some cushions on the floor. It was most evident that hers was no fancied case of illness; no effect of a morbid imagination; no effect of fear, for there was no evidence of fear of death. It was far more like the full consciousness that the fountains of life were being sapped. In a very short time a peculiar coldness, the cold clamminess of death, set in; but coincident therewith, the most remarkable symptom of all, viz., a sensation of burning heat, not so much internally, at first, as of the surface of the body; a sensation so intense that nothing would alleviate it but the external application of cold water. Yet the body was very cold to the touch, and next the nose, lips, and tongue became cold, followed by intense thirst, which nothing but cold water could assuage. The pulsation of the temporal arteries ceased, while the carotids throbbed laboriously and spasmodically. The plump, rounded form of the body began to be effaced; the skin of the fingers, toes, hands, and feet became shriveled, the features pinched, the eyes sunken and glaring, the voice hollow and sepulchral. Then the pulsation of the carotids ceased, the breathing became laborious, the breath was cold, the heart's action began to fail rapidly. The nervous system seemed intact; the intellectual faculties were clear, and motion and sensation were but slightly impaired. She was dead in four hours from the accession of the first symptom. There was no purgation." He noticed the same kind of attacks among children, who invariably cried without being able to explain what was the matter with them. They seemed instinctively to know the deadly nature of the seizure. He saw a man who felt himself taken ill, who at once went to his house, wrote out directions about his property and the liberation of his slaves, and was dead in four hours. He was perfectly calm and collected, had not the least fear, but knew he was going to die. Some negroes were attacked while going along the streets. While engaged in burying the dead, it was no unusual thing for them to be supported back to their huts, there to die, be rolled up in a mat, and carried back to the graves in less than six hours. The well-water in Zanzibar was horrible, and all these severe attacks could be traced to drinking freely of it while the stomach was empty.

EXTRACTION OF A PISTOL-BALL FROM THE BRAIN.

By WILLIAM F. FLUHRER, M.D., Professor of Clinical Surgery in the New York Post-Graduate Medical School and Hospital; Visiting Surgeon to Bellevue and Mt. Sinai Hospitals.

ABOUT three years before I performed the operation which I am about to describe there was admitted into the Ninety-ninth Street Hospital, of which I was then in charge, a young man suffering from a pistol-shot wound of the brain. The bullet had penetrated the center of the forehead, and at the time of my visit the patient was unconscious. To give exit to the pent-up discharges from the wound, and to relieve the brain from pressure, I freely incised the wound in the soft parts and chipped away bone from the margin of the bullet-hole. There was a marked but transient improvement of the symptoms. At the post-mortem examination, two or three days later, I observed that the bullet entering the skull had taken a straight course through the brain to the opposite side of the skull, striking which it had rebounded into the brain, and was deflected downward about an inch, where it lodged at a slight depth beneath the membranes. I further observed that the wound through the brain had begun to granulate and acquire a distinct wall that opposed considerable resistance when felt with the probe.

The course of the ball appeared to me what might have been expected; it seemed reasonable that the missile, moving through a medium of uniform resistance like the brain-substance, would take a straight course to the opposite wall of the skull, where it should rebound and be deflected at an angle proportionate to the inclination of the inner surface of the skull, and, from its greatly lessened velocity, lodge not far from the surface of the brain. Impressed by the conditions found at the post-mortem examination, I resolved that in another instance of similar injury I would try to track the bullet, and, after extracting it, drain the wound. This resolution was confirmed by reflecting upon the instances of brain injury within my experience, wherein, on the one hand, good drainage had contributed to a favorable result, while, on the other hand, faulty drainage had sometimes led to disastrous consequences.

On the 24th of January, 1884, I was informed by my house surgeon that Bruno Knorr, a healthy young man, nineteen years old, had, on the morning of that day, been admitted into one of my wards at Bellevue Hospital, suffering from a pistol-shot wound penetrating the brain through the center of the forehead. On my visit at 3 P. M. I found the patient semi-unconscious. When aroused he was irritable, and in answer to all questions grunted "ja." There was complete loss of motion without loss of sensation on the right side of the body below the head. The left side of the body was hyperæsthetic. This increased sensitiveness was very marked upon the left side of the scalp near the ear. The pupils were of equal size and rather widely dilated. His pulse was 100, temperature 101·4°. There was no history of the circumstances of the occurrence of the injury. It has, however, since been learned from the patient that, at about half-past four o'clock on the morning of the day of admission to the hospital, while lying upon his back he shot himself with a pistol held in contact with the forehead. Instantaneously he became unconscious, and remained so for about three-quarters of an hour, after which he awoke, and with much difficulty, on account of weakness from loss of blood, arose and left the house. He walked about an eighth of a mile, and then got upon a horse-car while in motion and took a seat inside. When called upon by the conductor to explain the nature of his injury, he could not speak, although he knew what he wanted to say. After riding about three-quarters of a mile he was put off the car by the conductor. He distinctly remembered having swung himself from the car with the aid of his right hand. After walking about an eighth of a mile farther, he stood upon the corner of the street till a policeman came and conducted him about one-third of a mile to the station-house. There he was questioned by the officer in command, but was unable to speak. Not long after he became unconscious. He was admitted into the hospital at about 8 A. M., when his wound, from which brain-matter was oozing, was dressed antiseptically.

Preparatory to the operation the patient's scalp was shaved. He was then etherized. A flap of gutta-percha tissue was fastened to his forehead to protect his eyes from the antiseptic solution of bichloride of mercury, 1 part to 1,000 of water, with which the parts were to be irrigated during the operation. The bullet-hole, of small size, was very nearly in the center of the forehead. The skin at the right margin of the opening was more ragged than at the left side. The epidermis was blistered off for a little distance from the opening. There were no powder grains in the skin. The soft parts were puffy.

To ascertain the direction of the wound through the soft parts and bone beneath, a silver probe with a large knob was passed into the wound perpendicularly to the surface of the skull. To pass the probe through the opening in the bone I found it necessary to direct its course outward at an angle slightly divergent from the median plane of the head. In passing the probe thus far, the right margin of the opening in the skull was felt to have a depressed shelving edge. An incision an inch and three-quarters long was then made from below upward to the center of the bullet-hole. This incision was parallel to the median line and just to the left of it.

From the center of the bullet-hole two other incisions of equal length were made divergent from the first one in a direction upward and outward. These incisions liberated some brain-matter that had collected between the scalp and pericranium. The flaps formed by the incisions were rapidly dissected back. The bleeding, which was quite profuse, was in great measure stopped by catgut ligatures applied to the larger vessels. The persistent bleeding from very small vessels was checked by traction upon the everted flaps by means of loops of catgut.

While the incisions were being made, and throughout the subsequent steps of the operation, the wounds were kept constantly wet by frequently repeated irrigations with the antiseptic solution. The bullet-hole in the skull was about half an inch in diameter; its left margin was sharply cut and formed by the external table, which slightly overhung the inner table; its right margin was shelving and depressed, the external table being fractured in concentric curves for a short distance from the margin of the opening. The shape of the hole in its depth through the bone indicated, what had already been ascertained by probing, that the ball, in its backward course, had diverged at an acute angle from the median plane of the head. The pericranium was cut along lines corresponding to the external incisions, and gently pushed back from the bone in the vicinity of the bullet-hole. The bullet-opening was then enlarged—brain-substance meanwhile escaping—by gnawing away with a *rongeur* forceps the bone at the left and overhanging margin. A small rim of lead weighing one grain, stripped from the bullet as it passed through the bone, was picked from the skull at the right margin of the bullet-hole. A small piece of bone, which at first, from its discoloration, was supposed to be a part of the bullet, was found lying upon the brain, and removed. While enlarging the opening in the skull a small clot was disturbed, which gave rise to a slight but persistent arterial bleeding from beneath the depressed fragment at the right margin of the bullet-hole. The portion of the external table holding this fragment was cut away. Upon the removal of this fragment from the inner table, whose sharp convex edge had been driven into the brain, the arterial hæmorrhage became alarmingly profuse. To this arterial bleeding was now added a considerable venous flow from the superior longitudinal sinus, which had been cut across by the bullet. While the wound was cleared of blood by the stream from the irrigator, the arterial blood was seen to come from a vessel in a small flap of pia mater on the inner side of the first frontal convolution at the border of the cerebral hemisphere. No sponges were used upon the lacerated brain during the operation. The bleeding point, constantly in motion, only imperfectly seen under the irrigating stream, and with a soft backing of contused and lacerated brain-structure, was only after considerable difficulty seized with a Langenbeck's artery-forceps. The opening in the skull was three-quarters of an inch by an inch and three-quarters. While I held the forceps, the ligation of the thin-walled vessel in its grasp was intrusted to an assistant, who, in his attempt to tie the vessel, tore it. The shortened artery now bled alarmingly. The wound could not be so cleared of blood as to yield a view of the vessel and permit its seizure. I found that the bleeding could be restrained, though not completely stopped, by pressing with the ball of the thumb through the opening in the skull back upon the brain. The bleeding point could then be felt forcibly striking against the thumb. While compression was thus exerted by an assistant, the primary incision upon the left side was rapidly extended, the soft parts were reflected, the bone was uncovered of its pericranium, and a disk of bone five-eighths of an inch in diameter removed with the trephine at a spot above and to the outer side of the existing opening in the skull. The thin bridge of bone separating the trephine-hole from the main opening was cut away, and the opening enlarged laterally. Upon the withdrawal of the assistant's thumb about three-quarters of an ounce of mixed clot and brain-matter was forcibly extruded by the brain pulsations. While the wound was flushed by the stream of antiseptic solution, the vessel was seized with a Pean's forceps.

I saw that it was in a delicate flap of the loosened pia mater. It was caught close to a bifurcation, a large branch being plainly seen curving along the inner face of the hemisphere. While the Pean's forceps, moved by each brain-pulsation, was sustained upon the finger of an assistant, with the aid of two pairs of dissecting forceps I passed a carbolized silk ligature around the vessel and tied it. Upon removal of the Pean's forceps the pulsations of the vessel loosened and threw off the ligature, and the bleeding became as profuse as ever. After several flushings of the wound, I seized the vessel for the third time. It was caught, somewhat deeper than before, upon the trunk below the point of its bifurcation. I saw clearly that the vessel could not be tied.

Fearing that the slightest movement of the patient's head might tear the delicate vessel from the forceps and cause an inevitably fatal hæmorrhage, I decided to transfer the vessel to the grasp of a short and light clamp, that could lie in the wound without such risk of detachment. While I held the Pean's forceps in the left hand, with the right hand I passed the small clamp into the depth of the wound so that its opened jaws just encroached upon the end of the Pean's forceps holding the vessel; simultaneously, as the Pean's forceps was unlocked and its grasp loosened, the jaws of the smaller clamp were allowed to close upon the vessel. This critical maneuver was accomplished without tearing the delicate artery, or the loss of a drop of blood. The hæmorrhage from the superior longitudinal sinus had already stopped spontaneously. Two hours and a half had been spent in reaching this stage of the operation.

Having cleared away the formidable complication of hæmorrhage that had threatened the patient with speedy death, and his general condition being good, I proceeded with the attempt to follow the course of the ball with the probe. After having reflected much upon the subject of probing wounds of the brain, I had come to the conclusion to adopt the same method, so far as applicable, in their exploration that had been the outcome of my experience in the probing of other wounds.

In probing a wound, it is essential that the end of the exploring instrument shall be of such a size as not easily itself to wound the tissues and make a false passage. The end should therefore be large. Not only does a large extremity to the probe save the tissues from injury and diminish the chance of making a false passage without the exercise of an undue amount of force, but the large end, even when it is deep beneath the surface of the body, is easily discoverable by palpation or dissection. In probing a wound to learn its course, depth, and other features, we should be able to follow or infer with exactness, from the exposed portion of the instrument, the varying positions of its buried end. It is further essential, therefore, that the end shall hold a fixed relation to the shaft, or, in other words, that the probe must have sufficient rigidity to retain a given shape. This rigidity is requisite to the practice of another procedure to determine the location of the exploring extremity—namely, conjoined manipulation through the medium of the probe. The shaft of the probe should not only be rigid, but should also have a considerable bulk, that a large surface may be in contact with the fingers and subject to the informing touch. Finally, the probe fulfilling these requirements should be as light as possible, in order that the delicacy of touch should not be lessened in the exertion to move a heavy mass, and that vibrations that would otherwise be lost in the probe itself may be communicated to the hand. The probe combining these properties is made of tempered aluminum. The large end will generally pass along the sinuses connected with the wound, and, from its size and shape, it is often possible to tell the nature of the structures with which it comes in contact. It is only exceptionally that the smaller end need be used.

In probing, to curve the instrument is to complicate it and increase the chances of error in interpreting the position of the exploring extremity.

When the probe is curved near the exploring end, the other end of the shaft should be bent in the same plane in the opposite direction.

In case the sinus is tortuous, rather than complicate the exploring instrument, I am in the habit of simplifying the wound. Thus, in following such a sinus, the end of the instrument, after it has passed along one curve, should, if practicable, be brought toward the surface and exposed by careful dissection. The first curve having been eliminated, the rebent probe can be introduced through the new opening at the commencement of the second curve, and the latter explored.

In a thirteen years' active hospital service, I cannot recall that I have ever used, in the probing of wounds, the fallacious means of exploration afforded by a flexible mechanical instrument.

The patient's head was now placed in such a position that the presumed track of the ball to be probed was perpendicular to the horizon. This was done that the delicacy of touch might not be obscured by the effort to direct the probe out of a perpendicular. The ragged opening of the entrance of the ball was seen to be just at the inner edge of the hemisphere, in the first frontal convolution. The large end of a copper probe, shaped as shown in Fig. 2, was passed perpendicularly into the brain past the clamp holding the artery. In passing the probe into the brain I feared, in lessening my grasp to increase the delicacy of my touch, that the heavy instrument would slip through my fingers, plow a false passage through the brain, and thus render futile all further search for the ball. Accordingly, after the probe had been passed to a depth of three inches, it was withdrawn, and a perfectly straight, common Nelaton's probe selected as a substitute. This lighter instrument was passed to a depth of about six inches, where a soft resistance was felt, but which no effort was made to overcome. The depth to which the probe was passed established my inference that the bullet had passed through the hemisphere and struck the opposite side of the skull. The probe was left standing in the brain, and, from the direction of the portion protruding from the forehead, viewing the head at the side and vertex, the point upon the scalp was noted at which the probe would emerge if projected through the head. Having observed the shape of the skull at this place, a cross was marked upon the scalp with the scalpel at a point three-quarters of an inch lower down toward the base of the skull, in the supposed plane of the path of the ball. The probe was withdrawn. The wound was dusted with iodoform, and the flaps were temporarily drawn together, due regard being paid to the protruding handle of the little clamp that held the offending artery.

The point of the scalpel was then thrust to the bone through the center of the cross marked upon the scalp. Three incisions, diverging from a common center, were made in the same manner as in exposing the bone at the bullet-hole anteriorly. The flaps were rapidly dissected back from the pericranium, and retracted. All bleeding vessels were ligated. The pericranium was incised, and pushed back over a space large enough to admit the crown of a trephine, and a disk of bone five-eighths of an inch in diameter removed. The dura mater was healthy. The brain did not seem to beat with normal force, but this was doubtful. The dura mater seemed to cover a dark background. Catching the membrane with a uterine tenaculum, and lifting it from the surface of the brain, I slit it for a quarter of an inch in a direction toward the supposed point of emergence of the bullet. A small quantity of dark fluid blood oozed from the opening when the brain was pressed upon. Two large veins in the pia mater appeared at the opening in the dura mater. I at first thought that one of these veins had been wounded, but careful scrutiny of the wound, under repeated flushings from the irrigator, convinced me that these vessels were intact, and that the opening had been made upon effused blood beneath the dura mater, in the vicinity of the brain injury. The trephine-hole was enlarged with a *rongeur* forceps toward the assumed opening of emergence of the bullet. A grooved director was passed beneath the dura mater, and the slit in that structure lengthened in the same direction. More dark blood, of a sirupy consistence, issued when pressure was made through the opening upon the brain. The bone was still further gnawed away, and the opening in the dura mater was made large enough to admit the end of the index-finger. Although the light for the operation was a bad one, being that reflected from three or four candles by a tin wash-basin, I discovered two or three specks of brain-matter of about the size of pin-heads floating in the blood as it came from the wound. With the point of the index-finger I felt a resistance in the brain at the depth of about half an inch. Rather than explore this resistance with a needle, I thought it better to follow the trail of brain-matter. By cutting away more of the skull in the same direction, and enlarging the opening in the dura mater, more brain-matter appeared, together with a semi-fluid clot. By still further exposing the brain in the same direction, at last there came quite a gush of brain-matter, and the opening torn in the pia mater by the bullet, as it struck the skull and rebounded, became visible. This opening in the pia mater was about half an inch in length, and about three-quarters of an inch above the center of the trephine-hole. The probe was introduced through the opening in the pia mater in a direction toward the resistance felt with the finger. After passing about one inch, it came in contact with the bullet at a depth of about half an inch below the pia mater. By the aid of a slender-bladed anatomical forceps, the battered bullet, weighing forty-two grains, was extracted. Thus was the bullet tracked by means of the probe

throughout its whole course to its place of lodgment and removed.

The patient's head having been placed in the same position as during the first trial, the Nelaton's probe was again gently passed through the wound through the brain. At a depth of about six inches it met with a resistance. Leaving the probe standing in the brain, by gentle pressure with the tip of the finger in the posterior wound I could stir the probe, and felt that the obstruction to its passage was the dura mater alone. After slitting this membrane for a quarter of an inch farther, the end of the probe passed readily into view. At a depth of about five inches from the anterior opening I thought I detected a foreign body in the wound. But there might have been contact of the handle of the probe with the little clamp in the anterior wound, for when this was held aside I failed to again feel any extraneous substance. However, this introduced a doubt as to the freedom of the wound from foreign matter, and led me to use a small-sized rubber tube instead of catgut for a drain. This tube had been made aseptic in a two and a half per cent. solution of carbolic acid, and was further washed in the bichloride solution. One end of the tube was slipped over the handle of the probe, and tied in place with carbolized silk. The probe was then drawn through the brain in the direction taken by the bullet. The tube, as it was drawn through the wound, became filled with brain-detritus and blood. No effort was made to clear its caliber by injecting the antiseptic solution through it. The blood in the tube could be seen pulsating. The projecting ends were cut off to within an inch and a half of the skull, and transfixed with safety-pins.

At both the anterior and posterior wounds the flaps were brought partly together by sutures at their bases, room being left for the ends of the tube and the artery-clamp. The wounds were dusted with iodoform, covered with Lister's protective silk, which was in turn dusted with iodoform. Over the protective, iodoform gauze was loosely packed, and over all a combined dressing of borated cotton held between layers of carbolized gauze was applied. The space beneath the brows having been filled with borated cotton, the eyes were covered in by the bandages which secured the dressings.

The operation was completed in about four hours from its commencement, the greater portion of the time having been spent in stopping the cerebral hæmorrhage. The following-named members of the house staff were present at the operation: Dr. R. T. Morris, Dr. J. R. Conway, Jr., Dr. W. W. French, Dr. J. H. Woodward, Dr. H. N. Williams, Dr. P. Oppenheimer, Dr. H. S. Wildman, Dr. H. Herman, Dr. H. Biggs, Dr. E. Hurd, Dr. C. F. Roberts, and Dr. W. G. Rutherford.

The patient's general condition after the operation was about the same as when it was undertaken. He was transferred to the Sturgis Pavilion, special orders being given that he should not be allowed to suffer from retention of urine, and that pain should be relieved by sufficient doses of morphine.

At nine o'clock P. M. the patient's temperature was 101° F., his pulse 120, and respiration 32. A hypodermic of Magendie's solution of morphine, ♏vii, was given; his urine was drawn by gum-elastic catheter.

January 25th.—The patient is in about the same condition as before the operation. He is semi-comatose, still hyperæsthetic upon the left side of the body, and irritable when aroused. He drinks milk with an apparent relish, and puts out his tongue when told to do so. His urine is drawn by catheter.

[From this time onward there was a gradual improvement and final recovery.]

In treating the herniæ cerebri it was my aim to deal gently with them, at the same time keeping the wounds aseptic. In the period of their formation no pressure was made upon the brain protrusions. I looked upon their production as in part due to swelling of the cerebral tissue as a result of its injury, and based my non-interference upon the intolerance to pressure of acutely swollen or inflamed wounded tissues. From this point of view, the openings, of considerable size, in the skull were a benefit in the treatment of the deep brain injury in its early stage rather than a disadvantage. In a later stage, however, when the brain protrusions had reached their greatest size and the course of the wounds had become chronic, I thought it advisable to aid the recession of the herniæ by gentle and evenly applied pressure.

On May 22, 1884, I exhibited Knorr at Bellevue Hospital to a number of physicians. He was then, so far as could be judged, in perfect health. Apart from the scars upon the patient, the only abnormality discoverable was a limitation of the visual field for green and red observed by Dr. W. F. Mittendorf. Inasmuch as this feature was common to both eyes, it is questionable whether it was caused by the injury.

The engraving is from a photograph of the patient taken at that time. The light line marks the position of the fissure of Rolando. The bullet entered at the center of the forehead, an inch and a quarter above the upper level of the eyebrows; it passed in a straight line through the brain from *a* to *b*, and was deflected to *c*, where it lodged. Its place of lodgment was an inch and a half to the left of the posterior median line. The course of the ball is shown by the dotted line. The probe having been passed from *a* to *b*, that portion of the wound was eliminated in the further search for the bullet. The probe was then passed from *b* to *c*, after the same method as described for the exploration of a tortuous wound. The bullet could have been followed about three inches farther upon its deflected course till arrested by the tentorium, the end of the probe being exposed by a second counter-opening in the skull.

The bullet cut upon the superior longitudinal sinus and penetrated the brain in the first frontal convolution, just at the edge of the hemisphere, where the convex surface joins the inner surface; traversing the brain-substance of the hemisphere, it emerged and lodged in the superior parietal convolution. The distance between the two openings in the brain, in a straight line, was six inches and a quarter.

In order to locate the injured cerebral artery with reference to the course of the ball, I carefully marked upon a cadaver the points of entrance and emergence of the bullet. I then removed a section of the skull to enable me to pass a straight-edged, long knife through the brain, in a straight line between these points. Upon removal of the brain, it was found that the cut in the first frontal convolution was down to a large branch of the anterior cerebral artery, lying about half an inch from the surface of the brain.

The patient left the hospital, where he had for a long time been retained simply for observation, on June 30, 1884.

About the 1st of August the patient went back to work at his old employment in a butcher's shop. He remained at work during the exceptionally hot weather in the early part of September.

On September 12, between twelve and one o'clock in the morning, Knorr received a heavy blow in the anterior scar from the elbow of the man with whom he was sleeping. Knorr states that he suffered intense pain in the head for half an hour, when it died away, and he fell asleep again. He awoke at about four o'clock and noticed, with wonder, his right forearm beginning to flex upon the arm. He tried to hold it down with his left hand, but failed. Then his right leg was drawn up. Then his left upper and lower extremities, respectively, became affected in the same manner. He remembered being asked what was the matter, and that he could not speak, but screamed, and then lost consciousness. The convulsive movements were so energetic that the patient was thrown from his bed upon the floor.

The same day he went to work, but did not feel well. The physician who attended him during my absence from the city prescribed twenty grains of bromide of potassium with fifteen grains of bromide of sodium, in a wineglass of water, every four hours. The medicine acting as a cathartic, Knorr took it rather irregularly, and for ten days prior to October 1 had abstained from its use altogether.

On October 1, while delivering a parcel at the house of a customer, he was seized with a slight rigidity, followed by a short convulsive movement of the limbs and a momentary loss of consciousness, but did not fall. He walked away and continued to work all that day, but he "felt sick all over." He consulted me upon my arrival home that day. I immediately impressed on him the importance of persistently continuing to take his medicine. I prescribed fifteen grains of bromide of sodium with thirty grains of bromide of potassium, to be taken, largely diluted, every morning and evening.

He soon came under the influence of the medicine, as

shown by the eruption of acne, insensibility of the fauces, and diminished excitability of the genital organs.

He has continued to take the bromide in doses of twenty grains in the morning and thirty grains in the evening, and has had no recurrence of convulsions or other epileptic symptoms whatever for a period of nearly six months. When he began working after his discharge from the hospital, he noticed, in trying to keep in mind the orders for deliveries to customers, that his memory was not so good as before the injury. He now follows the same occupation, and performs the same duties in it, as before he was shot. He feels perfectly well, and, by the test mentioned above, is sure that his memory is constantly growing more retentive.

The openings in the skull are closed simply by the soft parts. The posterior scar is depressed about three-eighths of an inch, and pulsates to the touch. The anterior scar, which for a long time was very thin in two spots, is constantly growing firmer. It is depressed one-quarter of an inch, and visibly pulsates. Each scar bulges about one-quarter of an inch above the surrounding surface when that portion of the head is made dependent.

The advisability of extracting from the brain a deeply lodged projectile follows, necessarily, from the case of Knorr.

In my lecture of May 22 I said that, had I found the bullet embedded near the center of the hemisphere, it was my intention to push the ball on and to extract it through a posterior opening in the skull. In such a contingency as supposed, I advise the adoption of the following procedure:

The patient's head having been placed so that the path of the ball is perpendicular to the horizon, the probe should be passed down to the ball. Contact having been made with the bullet, the probe should be pushed on in the direction of the existing wound till it is arrested by the opposite wall of the skull. The end of the probe is then exposed by trephining and made to emerge. Two strands of disinfected silk are then tied to the end of the probe protruding from the opening of entrance. The probe is then drawn through the head, leaving the threads reaching through the wound. The probe is then reintroduced through the opening of entrance, and the exact depth of the bullet from that opening determined; but no attempt should be made to push it on, lest its relation to the existing wound through the brain be disturbed. The probe is then withdrawn. The distance of the ball from the opening of emergence is thus ascertained. A long probe or wire is so bent that its ends reach the two openings in the brain as a pair of calipers, and from the total length of the brain-wound, as shown by measurement between the ends of the probe or wire, is subtracted the already determined measurement of the depth of the ball from the opening of entrance. It is premised from the foregoing procedure that the bullet lies in the wound through the brain, or in immediate connection with it.

In the effort to extract the ball there must be no groping outside of the existing path in the brain. While such action would inflict most serious injury to the brain, the increased difficulty would render the finding of the bullet, even if successful, mere chance-work. The path through the brain, and which leads directly to the ball, should be preserved by a suitable guide. This guide should not be of metal, for then it could not be distinguished from the ball in the search for the latter. A gum-elastic English catheter (No. 3 English, No. 9 French scale) upon its wire stylet should be carefully straightened to serve the purpose of a guide. A catheter of this small size, while it has sufficient bulk and rigidity, does not completely fill the wound, but leaves some room for exploration without passing outside the already established path. One of the threads at the opening of entrance is, with a needle, carried through the center of the end of the catheter and out at its eye, and tied fast. By means of the conducting thread the catheter upon its stylet is carefully lodged in the wound through the brain, its ends projecting from the skull. This having been successfully done, the reserve thread through the wound should be withdrawn. The head should now be turned so that the guide lies nearly in a horizontal plane, easy for manipulation. The instrument for extracting the bullet is a pair of long, slender-bladed, double-toothed, self-closing cervix forceps. The teeth should be short and set pointing forward and outward. The action of the forceps should have been tested with a view to avoid displacement of the bullet in an attempt to seize it. The forceps is prevented from straying from the single and correct path leading to the ball by tying it to the guide. The end of one of the blades just behind the teeth is notched on one side with a file. A delicate but strong silk thread is tied to the blade at this place, and is thus prevented from slipping; the thread is then tied in a loop a little larger than the size of the guide, the ends being cut short to the knot. The loop is passed over the guide and the closed forceps introduced alongside of, and parallel to, the guide into the wound in the brain. If the loop fails to slip upon the guide, the guide should be allowed to move with and as a part of the forceps. If the end of the guide is likely to be carried within the skull, it can be easily pushed back while the forceps is held immovable. With the lightest and most sensitive touch, search is made on one side of the guide to the known depth of the ball. Failing to find the bullet there, the forceps is withdrawn, and the bullet is sought for on the other side of the guide, and then above and below. When the bullet is felt, care should be taken to make an effectual seizure. The bullet and guide should be withdrawn together.

To verify the practicability of this procedure, I implanted a small conical ball, weighing twenty-seven grains, through the forehead, three inches deep in the left hemisphere of the brain of a cadaver. The pointed end of a long, small-sized, stiff wire was screwed obliquely into the bullet. Over the wire was slid a tube whose end next to the bullet had been filed into three points of unequal length. The bullet thus mounted was thrust into the brain, and, while it was steadied against the points at the end of the tube, the wire was unscrewed and the bullet deposited. The tube and wire were withdrawn, and the head was moved about in different directions.*

All previous steps of the procedure having been successfully carried out, and it having been learned that the ball had been pushed half an inch toward the counter-opening, I introduced the forceps and explored along one side of the guide, but failed to find the ball. I withdrew the forceps and introduced it upon the opposite side of the guide, and at once detected and extracted the bullet. The bullet was removed within three minutes from the beginning of the search with the forceps. The brain was then examined, and found uninjured outside of the straight and smooth path through its substance. All the steps of this procedure were carried out and the brain examined in the presence of my clinical assistant, Dr. John R. Conway, Jr., and my house surgeon at Bellevue Hospital, Dr. Willis W. French.

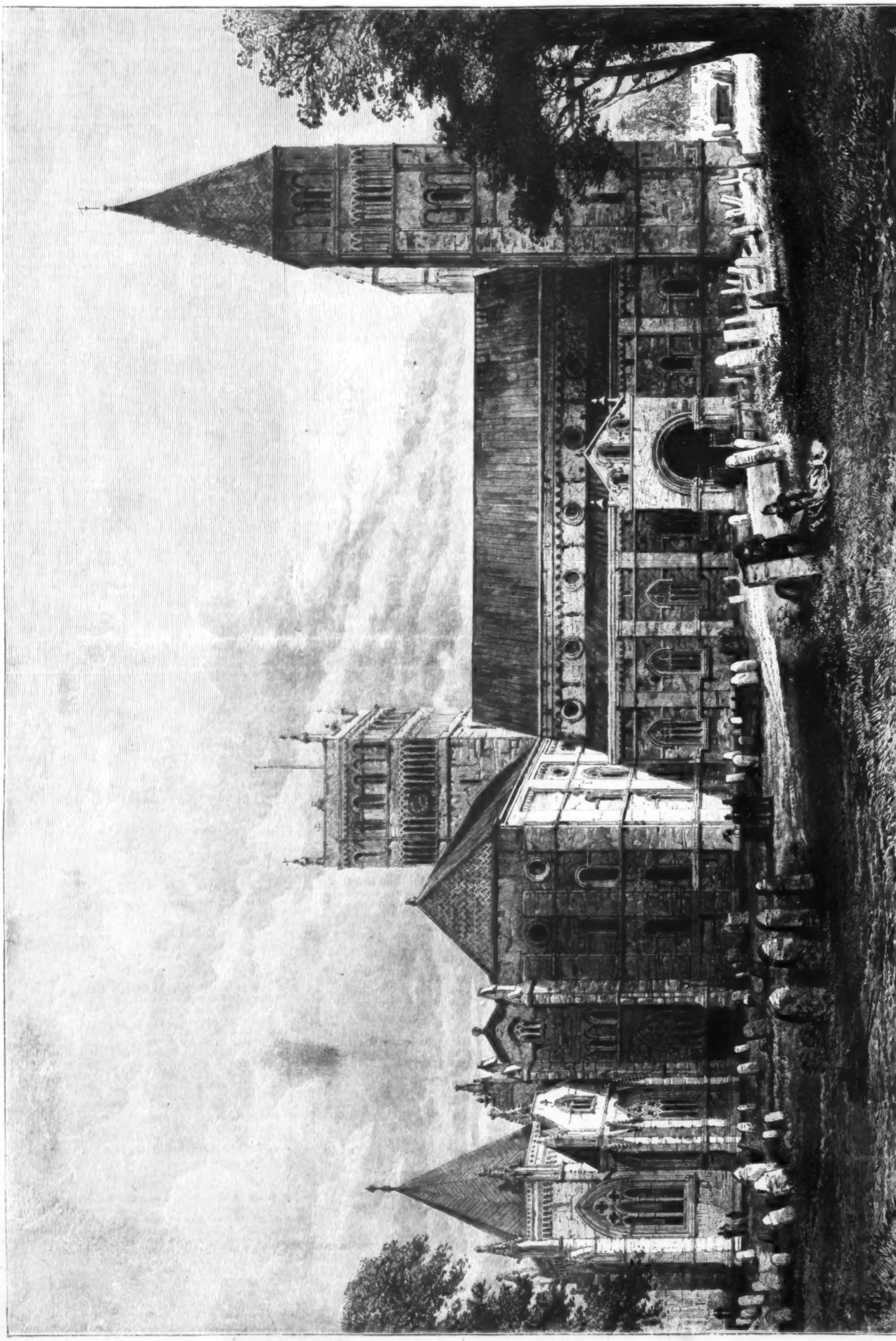
A fragment of bone deeply lodged in the brain could be removed by the same procedure.

Assuming that the attempt to extract the ball according to the advised method of procedure should fail, there has been established a path leading to the ball for drainage, through which a horse-hair drain or rubber tube can be passed. It may be assumed that the ball, passing along the line of least resistance, would tend toward this path, and there would remain the possibility that a second search, four or five days later, might be successful.

If a missile penetrating the brain strikes any of the bony irregularities at the base of the cranium, or if it changes its course at any point below the surface of the brain, it cannot be tracked with the probe and removed by the procedure practiced in the case of Knorr.—*N. Y. Med. Jour.*

DR. RICHARDSON calls attention to the much overlooked value of sponge as a poultice carrier, especially for mustard. After the mustard paste has been made of a smooth and even consistency, it should be taken up on a clean sponge, the sponge laid in the center of a soft white cloth, the corners of which are tied, and the smooth convex side of the sponge is then applied to the surface of the skin. The mustard sponge, warmed again by the fire and slightly moistened, can be applied two or three times, and remains useful for several hours. The sponge can afterward be easily cleaned in warm water.

* This same bullet I extracted before the class from beneath the sciatic nerve, next to the femur, in a hospital patient. In that instance I detected the bullet with the probe eight days after the patient was shot, although he had been subjected to fruitless probing just after the accident.



SOUTHWELL CATHEDRAL.

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SOUTHWELL CATHEDRAL.

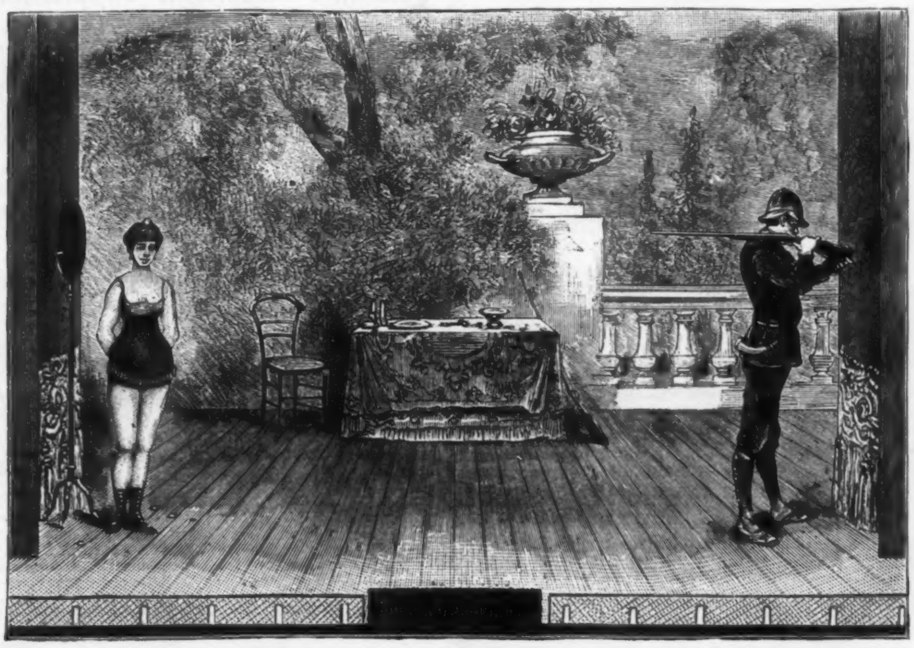
THIS fine old ecclesiastical edifice at Southwell, Nottinghamshire, has recently become the cathedral of the newly created episcopal see. It was founded in the seventh century by Paulinius, Archbishop of York, as a monastic institution; but the existing church is of mixed Norman, early English, and perpendicular architecture.—*Illustrated London News.*

EXPERTS IN SHOOTING.

THE skill of certain pistol shooters is proverbial. We find especially cited the case of Mr. D'Houtetot, who amused himself with cutting the stalk of a flower at twenty-five paces. The prowess will be recalled, too, of the Chevalier Saint Georges, who, it appears, nailed the cotton cap of an innkeeper to his sign post by loading his weapon with a horseshoe nail instead of a ball. Some marksmen strike, almost to a certainty, a ten-centime piece thrown into the air. A story is even told of a marksman who, throwing a one-franc piece into the air, struck it with such accuracy that nothing but a ring of silver fell to the ground; but this story appears to be legendary. Prince Bibesco performs a very pretty experiment. He puts a hole through the center of plates thrown into the air at fifteen paces from him, and succeeds in doing this several times in succession. The ball, in this case, instead of breaking the plate, passes through it and leaves a narrow aperture, this being due to a curious effect of inertia. Another pretty experiment based upon inertia is to place a cork upon the neck of a bottle and a coin upon this, and then to shoot away the cork so as to cause the coin to drop into the bottle.

In all shooting ranges there are to be found amateurs who can break the stem of a pipe to a certainty, and that, too, without hesitation, and even point out the very head, and knocking the ashes from a cigar held in the mouth. These two latter experiments always occasion some disquietude among the spectators, for fear that a failure of skill, or at least an involuntary movement, may cause the ball to deviate and crush the lady's head. Such fear is not well founded, for Mr. Paine has reached such a degree of dexterity that the maximum variation of his balls at twelve or fifteen paces never exceeds one centimeter (0·4 inch). Now the cigar ashes are three or four centimeters from the mouth, and the nut, taking the support and the thickness of the hair into consideration, is five or six centimeters above the skull. So no one need have any fear as to Mrs. Paine's fate.

Among the rifle exercises, those performed by Ira Paine, Jr., aged 15 years (the "Young Nimrod," as the posters call him), are peculiarly remarkable. His father throws cardboard targets into the air, and the boy hits them with a ball. In the experiments that we witnessed all the balls struck the bull's eye. Another exercise consists in hitting balls thrown into the air. This is an amusement much in vogue in this country, the object being to get one's hand in practice before the opening of the hunting season. Some amateurs excel in it, and are capable of breaking eighteen or nineteen balls out of twenty. Professional marksmen perform this exercise with much skill; but naturally in this case their rifle is loaded, not with balls, but with very fine lead—very small shot, for example. Mr. Ira Paine performs a very pretty feat: throwing two balls up with his own hand, he breaks them with a double shot that would be the glory of a good hunter. Another exercise of professional marksmen consists in firing backward without looking at the object, the rifle barrel resting upon the shoulder or head. This is done through a trick; for the marksman really sees the object—not directly, but through the reflection of a mirror placed between the scenes. It is none the



AN AMERICAN MARKSMAN SHOOTING AN ORANGE FROM THE HEAD OF A GIRL.

place where their ball will strike. From this to knock the pipe out of the mouth of an obliging person is but a step, apparently. With certain persons, even though not very impressionable, the difference is enormous, and there rises a physiological difficulty that merits attention. As well known, pistol duels are generally less dangerous than those fought with the sword. This is partly due to the impression that most duellists experience when they have to aim for the first time at an isolated person at a short distance, and this, too, independently of any feeling of personal fear. This trouble has often proved the safeguard of the combatants, even when they were excellent marksmen. At other times, when merely a question of skill, it has been the cause of grave accidents. The following is an example: In a small city of Brittany containing a garrison, there was a young lieutenant who was very skillful with his pistol. One day he bet that he could break the stem of a pipe held in the mouth of his orderly. The latter, sure of the skill of his officer, willingly submitted himself to an experiment that was to take place in the presence of a dozen persons. The officer, sure of himself, leveled his weapon; but, just as he was pulling the trigger, the feeling of his responsibility and the consequences of an accident occurred to him. He hesitated, his hand trembled, the pistol went off, a loud cry was heard, and the unfortunate trooper put his hand to his blood covered head: the ball had removed his nose.

Professional marksmen are of two kinds. The first of these go about from contest to contest, and, utilizing their habitude of shooting and their skill, carry off the first prizes. When the latter consist of works of art or weapons of value, the victor sells them. The rules of nearly all contests are directed against these peripatetic marksmen, whose competition is so much to be dreaded by simple amateurs. A story is told of one of these persons who, taking refuge in Switzerland in 1871, in a few years won enough arms, decreed as prizes in contests, to set up a gunsmith's shop.

Other professional marksmen exhibit in public, the two most celebrated of such—Messrs. Carver and Paine—having recently exhibited in Paris. Among the most astonishing experiments performed by Mr. Ira Paine at the Theatre des Folies-Bergere we may cite the piercing (with a pistol) of an ace of hearts held in the hand, the piercing of a three-spot of hearts held in the same way, cutting a card presented by its edge, striking a ball of the size of an orange swinging at the end of a cord, breaking a nut placed upon Mrs. Paine's less, for all that, a very remarkable exhibition of skill. —*La Nature.*

A RIFLE EXPERT.

BESIDES the commoner exploit of "knocking spots" out of playing cards, Miss Lilian C. Smith, the phenomenal young rifle expert of California, has recently made some remarkable shots. Around the figure of a deer, suspended in mid air, balls were attached by wires. With a seven pound Ballard rifle, the girl, a San Francisco contemporary tells us, "broke ball after ball at a distance of thirty-three feet with unfailing aim, firing both from the right and left shoulder, shooting with the rifle held upside down, and backward over the shoulder, sighting with a hand mirror. These shots she repeated with the sights obscured by a card on the muzzle of the rifle. One of her most remarkable feats was the breaking of a glass ball revolving on a wire cord in a horizontal circle, with a radius of about six feet. This feat she also performed shooting backward, using a hand mirror to sight with. Ten glass balls were sprung from a trap with only four-foot rise, and every one broken before they reached the floor. Twenty balls were attached to the deer, which was caused to swing, and every one broken inside of a minute without a miss. Two small balls no larger than a hazlenut shared the same fate, and a nickel five cent piece concealed by a card was perforated in the center."

ON THE DEVONIAN AGE OF THE GREEN POND MOUNTAIN ROCKS.

THE members of this series cover a considerable area in New Jersey and in Orange Co., N. Y., forming a long, narrow ridge of considerable height, bearing, at different points, the names of Green Pond, Copperas, Kanouse, Bearfoot, and, in New York, Skunnemunk Mountain.

The age of these rocks has never been considered by geologists to have been satisfactorily determined, and their study was attended with many difficulties, especially in New Jersey, where immense bodies of drift cover the contacts with the rocks of the associated formations, and no thorough examinations of these rocks have been entered into.

Rogers in his first Report on the Geology of New-Jersey* refers to the series as probably overlying the magnesian limestone, and in his final Report† describes the formation in greater detail, and with little or no stratigraphical evidence, but from the similar rocks and dip considered them as probably equivalent to the middle secondary formation so well developed farther southeast, and now known as the Triassic red sandstones. His conclusions were as follows:

"The striking analogy which these rocks bear, however, to the strata of the middle secondary series, both in composition and appearance, and their lying in the same unconformable manner upon the previously uplifted rocks of the Appalachian group, induce us to consider them as deposits from the same mass of waters. This suggestion acquires additional weight when we reflect that the long and narrow valley embracing this belt of conglomerate and sandstone opens immediately into the great basin of the middle and secondary series.

From the denuded condition of the southwestern portion of the Green Pond range, and from the apparently natural outlet which German valley would afford for the waters in their passage across this mountainous district, it seems not improbable that these rocks once filled the bed of this valley throughout its whole length as far as Clinton.

At the final elevation of the red shale and sandstone rocks, if, as we suppose, these *strata* were also uplifted, the extensive dislocation to which they have obviously been subjected will account for the removal of a portion of the beds, exposed as they must have been to the full violence of the floods thus set in motion.‡

In 1842 Ebenezer Emmons referred to the age of this formation in his Report on the Northern District of the New York Geological Survey, and considered it as an outlier, equivalent to part of the first Graywacke of Eaton, the upper Taconic of later writers. Eaton, however, assigned the formation to the same horizon as the rocks of the Shawangunk range westward, which is resembles lithologically.

Horton in his Report on the Geology of Orange Co.§ describes the principal features of the formation in that district, and mainly from stratigraphical evidence places it above the Hudson River slates at about the horizon of the Oneida Conglomerate of central and southern New York.

Mather in 1843‖ adopts this view, but adds: "The observations on the Geological Survey of the first district of New York do not *quite demonstrate* the age of these rocks." He calls attention to the occurrence of rocks of the Helderberg division at Townsend's iron mine near Cornwall, not far from the northern end of Skunnemunk Mountain, and recognized by an abundance of characteristic fossils; and although these members evidently may or may not overlie the formation under discussion, he considers this association very satisfactory evidence that the age is greater than that of the middle secondary, to which, as before stated, Rogers was inclined to refer them; and in conclusion, that the formation is "probably the geological equivalent, and in fact identical with the red rocks overlying and interstratified with the Shawangunk grits," and calls attention to its probable extension northeastward across the Hudson River from Fishkill, through Dutchess, Columbia, Rensselaer, and Washington counties, into the State of Vermont at West Poultney, which from its commencement in central New Jersey would be a distance of over 200 miles.

In 1868 Cook in his Geology of New Jersey ¶ describes the formation in that State, giving several ideal sections across it, and without preliminary discussion designates it Potsdam, equivalent** to the Primal of Rogers; and it has since been shown on the maps and referred to as Potsdam, directly overlying the Archæan rocks of the Highlands and underlying the magnesian limestones associated.

Hunt in 1883, in discussing the Taconic Question,†† refers to the age of these rocks, and points out their great difference, in composition and appearance, from the primal rocks underlying the auroral limestones in Pennsylvania, and is disposed to regard them, with Emmons, as a portion of the first Graywacke, but adds that the "relations of this formation to the auroral limestones often found adjacent, as well as to other and fossiliferous limestones and shales met with along the range both in New Jersey and New York, are complicated by many stratigraphical accidents, and demand further investigation."

During the past year a careful re-examination of the formation has been made by the New Jersey Geological Survey, and in the last Report an account is given of the finding of characteristic fossil plants and discovery of new localities exhibiting stratigraphical relations which has proved the Middle Devonian age, probably, of the entire series of Green Pond Mountain rocks.

The greater part of the evidence was obtained in New York State, and the cause of the previous assignment of this series to an erroneous position will be readily understood. The probable occurrence of overturned synclinals and of faults in the portions in New Jersey previously studied, and which make the newer formation appear to underlie the older, at once explains the error. Circumstances of this kind are often met with in geological studies, and when complicated by faults and in a district as heavily covered with drift as northern New Jersey, are often very difficult to interpret, and it is well known that some of the principal questions in American geology are still kept open by the possibility of complications of this kind. Another instance is in the geology of the Scottish Highlands, wherein the recent concession of the Precambrian age of which, by the Director of the Geological Survey of Great Britain, and which is such a significant victory for the New School of Geology, was due to the finding of the true relations of strata folded in an over-

* Report on the Geological Survey of the State of New Jersey, by Henry D. Rogers. Philadelphia, 1836, pp. 129 and 130.

† Description of the Geology of the State of New Jersey, being a Final Report, by Henry D. Rogers, State Geologist. Philadelphia, 1840, pp. 171-175.

‡ Ibid., p. 175.

§ Third Annual Report of W. W. Mather, Geologist of the First Geological District of the State of New York, 1839. Appendix by Dr. William Horton, pp. 146 and 147.

‖ Geology of New York. Part I., by William W. Mather. Albany, 1843, pp. 392-393.

¶ Pp. 71, 79 to 89, and 149.

** Ibid., p. 84.

†† The Taconic Question in Geology, by T. Sterry Hunt. Part I., 1883. Trans. Royal Society of Canada, I., Section IV., pp. 230, 253-254.

turned anticinal and displaced by a peculiar form of faulting, by slipping forward. A general description of the rocks and structure of the Green Pond Mountain series, in the light of the recent discoveries, is of interest.

The mountains formed by the folds of this series have a very uniform height of from 1,000 to 1,300 feet A. T., and seldom covering a width of over two or three miles, rough, barren, craggy ridges; their prominence due largely to erosion; they present a precipitous face southeastward, and its crest corresponds in trend with the adjacent Archæan system.

The series is generally composed of alternations of various kinds of conglomerates, sandstones, and shales, but there is also one very characteristic member, a conglomerate composed of white quartz pebbles, which are often subangular, cemented by a bright purplish, red silicious paste in considerable proportion. The sizes of the pebbles range from one-half to two inches in diameter, but are occasionally much larger, and blocks of this conglomerate are widely scattered in the drift beds southward. At many points this and similar conglomerates form the uppermost members of the series, and it appears probable that this is the universal relation except where locally disturbed.

The thickness of the series is difficult to determine, and appears to vary from 500 to 1,000 feet in New Jersey, but a greater development of the underlying members, the gray, thin-bedded sandstones and shales northward in New York, makes its thickness in Skunnemunk Mountain about 1,600 feet, including the 300 feet of conglomerate capping the eastern crest; the thickness probably does not vary greatly, except where locally eroded.

The structure of the mountains composed of these rocks has not been entirely worked out. Many dips have been determined, however, and the main features of the formation made apparent. The predominating structure is a synclinal fold, often with inclined axial dip as in the Green Pond Mountain, while the Copperas Mountain is formed by a normal synclinal fold. It was generally observable that in the Green Pond Mountain the beds near the southern end dip steeply toward the southeast; northward the direction is nortwestward, and at a less inclination on the eastern than on the western slope. The structure of the other ridges in New Jersey was too much obscured by faults, overturned foldings, drift, etc., to determine without a more extended study than was entered into.

The structure of the Skunnemunk Mountain in New York was carefully studied, and found to be a very characteristic one. A section across it is also given. The line of this section is from Woodcock Hill, near Washingtonville, Orange Co., due south to the top of the mountain, thence in an E. N. E. course to Mountainville, in the valley eastward. On this line are met with successively, first, the gneiss of Woodcock Hill, then the magnesian limestone, Hudson River slates (?), and Oneida conglomerate—the two latter unconformable, but all dipping eastward; then there is an interval without outcrops, stretching up to the foot of the mountain slope; next comes the flaggy sandstone, dipping eastward and overlain by the massive conglomerate, which forms by a gentle synclinal folding the irregular, double crested top of the mountain. In the eastern side gray sandstones are exposed, overlying the black slaty rocks of the valley, after which an interval with no outcrops extends to the gneiss.

A short distance north of the line of this section, and separated from the eastern side of the mountain by a considerable interval, occur the limestones and shales holding the lower Helderberg fossils before referred to, and east of these are rocks similar to those of the Medina on the western side of the Shawangunk Mountain. At various points southward, and into New Jersey rocks, apparently Oneida, and at Greenwood Lake, Medina also, are associated with the Green Pond Mountain rocks on either side of the mountain, those occurring in New Jersey being overturned with the formation, and thus appearing to overlie it, as shown in the 1868 Report.*

The relations to the magnesian limestone are also exposed at several points. At Gould's quarry, near Macopin, N. J., a section is traceable in which the gneiss on the eastern side is conformably overlain by sandstone, probably of Potsdam age, this by the limestone holding included fragments of the sandstone, all dipping toward and under the Green Pond rocks in Kanouse Mountain, 300 feet distant, the interval being drift covered.

A similar relation is exposed in Cisco's quarries, two miles north of Gould's. Near Upper Longwood the fossiliferous Trenton limestone appears to overlie the Green Pond rocks, as shown in a section in the 1868 Report,† but this apparent superposition may be due to an overturned fold in the strata, and the same is the case with the outcrops near Woodstock, in both of these instances the dip of the strata is near vertical. Much more satisfactory exposures of this kind are in the less superficial openings at Middle Forge, where the folding is *seen* to be an overturned synclinal. The remaining outcrops have not added to the evidence, owing to their small size and isolation.

The black slates of the basin surrounding the mountains of the formation are supposed to be of Hudson River age, and although not well exposed were also found to dip under the Green Pond rocks, except where overturned; and on the western side of the range in the West Milford valley the slate is plainly seen dipping away from an anticlinal axis toward the mountain, and the slate in Longwood valley and at Petersburg dips in a similar manner.

From these relations, and from lithological analogies, the Green Pond Mountain series would be placed in the Devonian, near the flagging stone series of Hamilton, Ulster, and Green counties, New York, and in Pennsylvania, but the finding of plant remains in the gray-red shaly sandstones of Skunnemunk Mountain has proved the age more conclusively.

The locality at which these remains were found most abundantly was in Davison's quarry, at the foot of the southwestern projection of the mountain, three miles north of Monroe, but they also occur on the east side, and near Woodbury Falls. The species found were identified by Dr. Newberry as *Lepidodendron Gaspianum* (Dawson), *Psilophyton princeps* (Dawson), and *Calamites transitionis* (Dawson), rhizomes of the second being particularly abundant. These fossils are the same species as those collected by Hall and Dawson in the Hamilton and Chemung of southern central New York. Attention is called to the resemblance of these rocks, in the great thickness of conglomerate at the top and prevalence of gray and green shales with red shales and sandstones, to the Catskill rocks or upper Devonian, but it is considered safer to place them in the middle Devonian.

N. H. D.

* Loc. cit., p. 149.
† Loc. cit., p. 94.

EARTHENWARE JARS FOR FERNS.

THE accompanying sketch was lately made in Mr. B. S. Williams' ferneries at Upper Holloway. It represents, as will be seen, a fern growing in an earthenware jar made of the same material as an ordinary garden pot; and being good in form it makes a really pleasing object, more especially as the surface is so roughed as to cause it soon to become covered with mossy growth, thereby softening the glaring red of the pottery ware. This way of growing ferns and other fine-leaved plants recommends itself to those who like to have plants in rooms, as it does away with the necessity of hiding the inelegant garden pot in some sort of vase. Moreover, these earthenware jars are porous and are otherwise

LOMARIA GIBBA IN AN EARTHENWARE JAR.

made suitable for plant growth; therefore plants may be grown in them for an indefinite period, which is not the case with ornamental vases that are often unsuitable for permanent plant growth. The plant represented in the accompanying sketch is Lomaria gibba, an excellent fern for the purpose, but there are others equally suitable, such as the Blechnum corcovadense, various kinds of Pteris, Nephrodium, Adiantum, Gymnogramma, and even small tree ferns, while palms also look well in such vases, and may be successfully grown in them.—*The Garden.*

NEW JAPANESE OAK.

(QUERCUS SERRATA.)

THIS is a highly ornamental species, with foliage exhibiting a decided resemblance to that of the Sweet Chestnut of Southern Europe. It is quite hardy in this country, and from its handsome appearance and distinct habit is thoroughly worthy of more general cultivation. In Japan it is widely distributed, and forms one of the most useful timber trees. Sections of the wood, both longitudinal and transverse, are published in a Japanese work, "Mokuzai Shoran," or "Handbook of Useful Woods." The young foliage is always more or less silky, but in the mature leaves the hairiness is sometimes confined to the axils of the prin-

LEAF OF QUERCUS SERRATA.

cipal veins on the under surface of the leaf. Full-grown leaves measure from 4 inches to 8 inches in length, and from little more than half an inch to 1½ inches across, the stalks being from a third of an inch to an inch long. As before stated, the leaves are like those of the Sweet Chestnut in miniature; in color they are deep green above and lighter—sometimes almost ashy gray below—parallel veins produced beyond the edge of the leaf into slender spring-like teeth. Q. serrata is also found in China, the Himalayan region, and Persia. Oaks which have received different specific names, but which seem to differ from Q. serrata no more than many different individuals of the British Oak from a single wood do from each other, exist in the Caucasus, Eastern Europe, and Asia Minor. Of these latter may be mentioned Q. Libani (Kotschy) and Q. castaneæfolia (C. A. Meyer). Q. serrata is easily recognized from the Turkey Oak (Q. Cerris) by the larger and more rigid scales of the acorn cups. The leaf of this oak represented by the above woodcut is one-quarter the natural size, and was drawn in Messrs. Lee's Isleworth arboretum.—*G. Nicholson, in The Garden.*

CITY TELEGRAPH WIRES.

THE Vienna telephone people have a practical way of putting up their wires, using neither poles nor housetops, and yet not going underground. They affix to the walls of the houses small and very neat iron frames, holding from eight to sixteen insulators. The wires are then strung along the tops of the buildings on these insulators, between the second and third story windows. It is said that the whole presents a very neat appearance, the wires being inconspicuous on account of their smallness.

We have several times endeavored to show that the true way to dispose of the overhead wire system was by legal regulation, not by compelling the placing of the wires underground. What the public requires is cheap telegraphy; this cannot be had if wires go underground. There is plenty of room on the buildings, and there need be no trouble if only a careful system in respect to the arrangement of the wires were adopted. Heretofore chaos has prevailed. Companies and individuals have been allowed to put up wires wherever and however they pleased, and a general tangle, disfigurement, and wire nuisance is the result. By the adoption of a system of regulation a great change might be made, as at Vienna.

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